9724

CONCORD INSTRUMENT
DIVISION

MODEL 6053
FREQUENCY COUNTER

SYSTRON DONNER

D.M.-TEST

# Concord Instrument Division

# INSTRUCTION MANUAL

*MODEL 6053 FREQUENCY COUNTER
FORMERLY DESIGNATED MODEL 6053/3

CONCORD INSTRUMENT
DIVISION

MODEL 6053
FREQUENCY COUNTER

© Copyright 1970 Systron-Donner Corporation

SYSTRON DONNER
CORPORATION

888 Galindo Street, Concord, California 94520, U.S.A.
Tel: (415) 682-6161, TWX: 910-481-9478, Cable: SYSTRONDONNER

SYSTRON DONNER
CORPORATION

# WARRANTY

Systron-Donner instruments are warranted during a period of one year from date of shipment to original purchaser to be free from defects in material and workmanship. This warranty does not apply to vacuum tubes, except as these are warranted by tube manufacturers. The liability of Seller under this warranty is limited to replacing or repairing any instrument or component thereof which is returned by Buyer, at his expense, during such period and which has not been subjected to misuse, neglect, improper installation, repair, alteration, or accident. Seller shall have the right to final determination as to the existence and cause of a defect. In no event shall Seller be liable for collateral or consequential damages. This warranty is in lieu of any other warranty, expressed, implied, or statutory; and no agreement extending or modifying it will be binding upon Seller unless in writing and signed by a duly authorized officer.

# RECEIVING INSPECTION

Every Systron-Donner instrument is carefully inspected and is in perfect working order at the time of shipment. Each instrument should be checked as soon as received. If the unit is damaged in any way, or fails to operate, a claim should immediately be filed with the transportation company.

# REPAIRS

Whenever a Systron-Donner instrument requires service, the nearest Systron-Donner representative should be contacted; all representatives will provide immediate service or arrange factory returns when necessary.

Please specify both model and serial number in all correspondence concerning Systron-Donner instruments. Address all inquiries on operation or applications to your nearest sales representative; or, Sales Manager, Concord Instrument Division, Systron-Donner Corporation, 10 Systron Drive, Concord, California 94518.

*CAUTION*

## IMPORTANT OPERATING INSTRUCTIONS
## (200 MHz to 3 GHz)

Signals to the "D" Input (50 Ω) connector *MUST NOT EXCEED* +20 dBm (2.2 V rms) at any time or serious (expensive) damage to the input circuit will result. Always monitor unknown signal levels first (terminated in 50 Ω), before connecting into the "D" Input of the instrument. When input levels exceed +20 dBm, insert a variable, calibrated attenuator between the signal source and the Model 6053.

TABLE OF CONTENTS


| | | Page |
|---|---|---|
| CHAPTER 1 - GENERAL INFORMATION | | |
| 1.1 | Introduction | 1-1 |
| 1.2 | Functional Description | 1-1 |
| 1.3 | Specifications | 1-1 |
| CHAPTER 2 - INSTALLATION | | |
| 2.1 | Introduction | 2-1 |
| 2.2 | Receiving Inspection | 2-1 |
| 2.3 | Installation | 2-1 |
| 2.3.1 | Power | 2-1 |
| 2.3.2 | Cooling | 2-2 |
| 2.4 | Reshipment | 2-2 |
| CHAPTER 3 - OPERATION | | |
| 3.1 | Introduction | 3-1 |
| 3.2 | Controls, Connectors, and Indicators | 3-1 |
| 3.3 | Initial Turn-On and Operational Check | 3-4 |
| 3.4 | Operating Procedures | 3-5 |
| 3.4.1 | General | 3-5 |
| 3.4.2 | 20Hz - .2GHz Range | 3-5 |
| 3.4.3 | .2 - 3GHz Range | 3-5 |
| 3.4.4 | Turn-Off Procedures | 3-6 |
| CHAPTER 4 - THEORY OF OPERATION | | |
| 4.1 | Introduction | 4-1 |
| 4.2 | General Theory | 4-1 |
| 4.3 | Circuit Descriptions | 4-1 |
| 4.3.1 | Power Supply (Schematic C39082) | 4-1 |
| 4.3.2 | A2, Shield Board (Schematic D39100) | 4-5 |
| 4.3.3 | A3, Counter Readout Assembly (Schematic D33997) | 4-5 |
| 4.3.4 | 200MHz Amp and Decade (Schematic D39095) | 4-10 |
| 4.3.5 | A5, Acto (Schematic C39087) | 4-11 |
| 4.3.6 | A6, Acto Mixer/Driver (Schematic C27988) | 4-12 |
| CHAPTER 5 - CALIBRATION-MAINTENANCE | | |
| 5.1 | Introduction | 5-1 |
| 5.2 | Factory Service | 5-1 |
| 5.3 | Part Location | 5-1 |
| 5.4 | Calibration Procedure | 5-1 |
| 5.4.1 | Power Supply Adjustments (Schematic C39082) | 5-1 |

TABLE OF CONTENTS (Cont'd)


Page

CHAPTER 5 - CALIBRATION-MAINTENANCE (Cont'd)

5.4.2 Oscillator Adjustment . . . . . 5-2
5.4.3 200 MHz Input Amp and Decade Adjustments (Schematic D39095) . . . . . 5-2
5.4.4 Acto Adjustment (Schematic C39087) . . . 5-3
5.5 Board Repair . . . . . 5-3

CHAPTER 6 - DRAWINGS AND PARTS LIST

Model 6053/3 Block Diagram . . . . . 6-2
Final Assembly Parts List . . . . . 6-3

C39082C A1, Power Supply Assembly D39085C . . . . 6-4
A1, Power Supply Schematic D39082D . . . 6-5
Parts List . . . . . 6-6

C39448R2 A2, Shield Board Assembly C39448R2 . . . 6-8
Parts List . . . . . 6-9

D333997B A3, Readout P.C. Assembly D39000C . . . . 6-10
A3, Readout Schematic (Sh. 1) D33997B . . 6-11
A3, Readout Schematic (Sh. 2) D33997B . . 6-12
Parts List . . . . . 6-13

D39095E A4, 200MHz Amp & Decade Assembly D39098F . . . . . 6-20
A4, 200MHz Amp & Decade Schematic D39095E . . . . . 6-21
Parts List . . . . . 6-22

C39087D A5, Acto P.C. Assembly C39090E . . . . . 6-28
A5, Acto Schematic C39087D . . . . . 6-29
Parts List . . . . . 6-30

C27988L A6, Mixer P.C. Assembly C33218J . . . . . 6-34
A6, Mixer & Driver Amp Schematic C27988L . . . . . 6-35
A6, Mixer Final Assembly C33351B . . . . 6-36
Parts List . . . . . 6-37
A6, Driver Amp P.C. Assembly C33221G . . 6-39
Parts List . . . . . 6-40

CHAPTER 7 - STANDARD OPTIONS

7.1 Introduction . . . . . 7-1

Option 10 Oscillator (B1) . . . . . 1

## TABLE OF CONTENTS (Cont'd)


Page

CHAPTER 7 - STANDARD OPTIONS (Cont'd)

Option 11 Oscillator (B3) . . . . . 1

Option 12 Oscillator (B) . . . . . 1

Option 13 Oscillator (B4) . . . . . 1

A7 Oscillator, Power Supply (Used with Options 11, 12, & 13) . . . . . 1
B39490R1 U1, 3MHz Oscillator Assembly B39487R1 . 2
U2, 3MHz Oscillator Schematic B39490R1. 3
Parts List . . . . . 4

Option 15 Decade Indicators (E) . . . . . 1

Option 16 Decade Indicators (EE) . . . . . 1

Option 17 Data Output (D3). . . . . 1
C39113B BCD Board Assembly A39897B . . . . . 2
BCD Board Schematic C39113B . . . . . 3
Parts List . . . . . 4

Option 20 Remote Operation (P) . . . . . 1


## LIST OF FIGURES


Page

Figure 2.1 Transformer Jumper Position for Power Change . . . . . 2-2
3.1 Front Panel, Model 6053/3 . . . . . 3-2
3.2 Rear Panel, Model 6053/3 . . . . . 3-2
4.1 Model 6053/3 Block Diagram . . . . . 4-3
4.2 Timing Diagram, Model 6053/3 . . . . . 4-4
5.1 Voltage Measurement of RF Input . . . . . 5-3


## LIST OF TABLES


Table 1.1 Specifications . . . . . 1-1
3.1 Front Panel . . . . . 3-1
3.2 Rear Panel . . . . . 3-3
3.3 Check, In Test . . . . . 3-5
4.1 Logic States . . . . . 4-6
4.2 Function BCD . . . . . 4-7
5.1 Power Supply Adjustment . . . . . 5-2

Digitized by the Internet Archive
in 2025

https://archive.org/details/manualsplus_08544

# CHAPTER 1
# GENERAL INFORMATION

## 1.1 INTRODUCTION

The SD Model 6053/3 is a portable, half-rack, microwave counter capable of automatically measuring signal frequencies ranging from 20Hz to 3GHz. Extensive use of integrated circuits and other solid-state components ensures excellent reliability and trouble-free maintenance.

The Model 6053/3 microwave counter provides the following operating features:

1. An easily read storage-type display which permits the initial reading to be observed while another is being made.
2. Direct reading of frequency with no front panel adjustment necessary.
3. Automatic units of measure and decimal point location.
4. Completely remote programmable: programming inputs for all front panel controls and attenuator switch (optional).
5. BCD recorder output (optional).
6. Unit can be operated on either 115V or 230V ac line.

## 1.2 FUNCTIONAL DESCRIPTION

The Model 6053/3$_R$ features the Automatic Computing Transfer Oscillator (ACTO$^R$) technique in conjunction with a new high-sensitivity, high input impedance .2GHz amplifier to offer unparalleled performance. The basic seven-digit instrument receives its input on one of two input connectors.

1. BNC - This 20Hz to .2GHz input channel features 10mV rms sensitivity and one megohm impedance. Input signals may be attenuated by factors from 1 to 1000, in decade steps.
2. "N" type connector - Frequencies from .2GHz to 3GHz can be measured with sensitivities of 50mV rms into 50 ohms.

## 1.3 SPECIFICATIONS

Table 1.1 lists the specifications applicable to the Model 6053/3:

TABLE 1.1 SPECIFICATIONS

| | | |
|---|---|---|
| Low-Frequency Range Input | Frequency Range: | 20Hz to .2GHz. |
| | Type of Signal: | CW. |
| | Sensitivity: | 10mV rms. |

TABLE 1.1 SPECIFICATIONS (Cont'd)

| | | |
|---|---|---|
| | Maximum Input Without Damage: | 600V dc, 200V rms. |
| | Input Impedance: | 1MΩ. |
| | Input Connector: | Type BNC. |
| | Accuracy: | ±1 count ±time base accuracy. |
| | Resolution: | 100kHz to 0.1Hz in decade steps. |
| | Reads In: | MHz or GHz. |
| High-Frequency Range Input | Frequency Range: | .2GHz to 3GHz. |
| | Type of Signal: | CW. |
| | Sensitivity: | 50mV rms (-7 dBm). |
| | Maximum Input Without Damage: | 2.33V rms (+20 dBm). |
| | Maximum Usable Input: | 500mV rms (+7 dBm). |
| | Input Impedance: | 50Ω nominal. |
| | Input Connector: | Type N. |
| | Accuracy: | ±1 count ±time base accuracy. |
| | Resolution: | 100kHz to 0.1Hz in decade steps. |
| | Reads In: | MHz or GHz. |
| | Acquisition Time: | 200ms typical. |
| | FM Tolerance: | Maximum of 0.1% deviation at modulation frequency of 60Hz. Permissible deviation is reduced 50% for each increasing octave of modulation frequency. |

TABLE 1.1 SPECIFICATIONS (Cont'd)

| | | |
|---|---|---|
| | **Lock-On Range:** | Approximately 5% of input frequency. |
| Time Base | **Crystal Frequency:** | 1MHz. |
| | **Stability:** | ±2 parts in $10^6$/month. |
| | **Temperature:** | Less than ±1 part in $10^5$ from +15°C to +35°C; less than ±3 parts in $10^5$ from 0°C to +50°C. |
| | **Line Voltage:** | Less than ±1 part in $10^6$ for 10% change in line voltage specified. |
| | **Output Frequency:** | 1MHz, 3V p-p minimum open circuit; source impedance 2000Ω maximum. |
| | **External Input:** | 1MHz sinewave, 1V rms into 1000Ω, 10V rms maximum. |
| | **Higher Stability Available:** | See options listed. |
| General | **Registration:** | 7 digits, expandable to 9. |
| | **Reads In:** | MHz or GHz with positioned decimal point. |
| | **Display Storage:** | Provides a continuous display of most recent measurement. |
| | **Rear Panel:** | 1MHz internal/external switch, BNC connector for 1MHz input or output, line cord, oscillator adjustment, fuse. |
| | **Operating Temperature:** | 0°C to +50°C. |
| | **Dimensions:** | 3-1/2" high x 8-3/8" wide x 13" deep. |
| | **Weight:** | 10 lbs. net (15 lbs. shipping. |
| | **Power:** | 115V/230Vac, 50 to 60Hz. |

TABLE 1.1 SPECIFICATIONS (Cont'd)

| | | |
|---|---|---|
| Options | B3 | Aging Rate: <±3 parts in $10^8$/24 hours. Long-Term Aging Rate: ±3 parts in $10^8$/30 days. Short-Term Aging Rate: ±1 part in $10^{10}$ rms/1s average. |
| | B | Aging Rate: <±1 part in $10^9$/24 hours. Long-Term Aging Rate: ±3 parts in $10^8$/30 days. Short-Term Aging Rate: ±1 part in $10^{10}$ rms/1s average. |
| | B4 | Aging Rate: <±5 parts in $10^{10}$/24 hours. Long-Term Aging Rate: ±1.5 parts in $10^8$/30 days. Short-Term Aging Rate: ±5 parts in $10^{11}$/1s average. |
| | E & EE | Additional decade indicator to increase count capacity to 8 (E) or 9 (EE) digits. |
| | D3 | 1-2-4-8 BCD Output: Coded output information of front panel reading appears at rear panel connector. Positive logic "1" state level at +5V nominal, "0" state level at 0V ±0.5V; a +5V print command at the end of each conversion, positive reference level is +4V, negative reference level is +1V with a column capacity equal to the number of digits. |
| | P | Remote programming of range, resolution and attenuators. $T^2L$, DTL compatible. |

# CHAPTER 2
# INSTALLATION

## 2.1 INTRODUCTION

Procedures for inspection and initial installation of SD Model 6053/3 are outlined below. Reshipment instructions have been included should the instrument require return to Systron-Donner Corporation.

## 2.2 RECEIVING INSPECTION

Before accepting the instrument from the shipper, inspect the shipping container for signs of external damage. Any sign of such damage must be noted by both the shipper and customer; then, should be reported to the insurance investigator.

As soon as the instrument is unpacked, inspect it for shipping damage. Check for scratches or dents, broken or cracked knobs, and damaged connectors. Should any damage be found, notify your nearest Systron-Donner representative -- do not use the instrument until instructed to do so by the representative.

## 2.3 INSTALLATION

Initial installation of the Model 6053/3 includes power connection and verification of internal cooling.

### 2.3.1 Power

The Model 6053/3 may be operated from a 115 or 230-volt ac (±10%) power source. Conversion from one source to another is performed by changing jumpers on the power transformer (See Figure 2.1).

The instrument is factory-supplied with a 1A, 3AG fuse for 115V operation. Be sure to replace this fuse with a .5A, 3AG fuse when operating with 230V.

*CAUTION*

*Before connecting instrument into ac power line, be certain that transformer is wired for proper power.*

The Model 6053/3 is equipped with a standard three-conductor power cord that automatically grounds the unit when a matching power outlet is available. An adapter which provides the instrument ground should be used whenever the power cord is connected to a two-conductor outlet.

### 2.3.2 Cooling

The Model 6053/3 Counter uses forced air cooling. The air intake is located on the rear panel of the instrument. Make sure the air intake filter is clean and in place before applying power to the instrument. Under no circumstances should the air intake be obstructed while the instrument is operating.

## 2.4 RESHIPMENT

Should it become necessary to reship the instrument, contact the nearest Systron-Donner field office for shipping instructions. If possible, use the original packaging materials, or replace the packing in accordance with MIL-P-116 and MIL-E-17555E. The field office can provide materials similar to those used for original factory packaging. All correspondence should refer to the full nomenclature and serial number of the instrument.

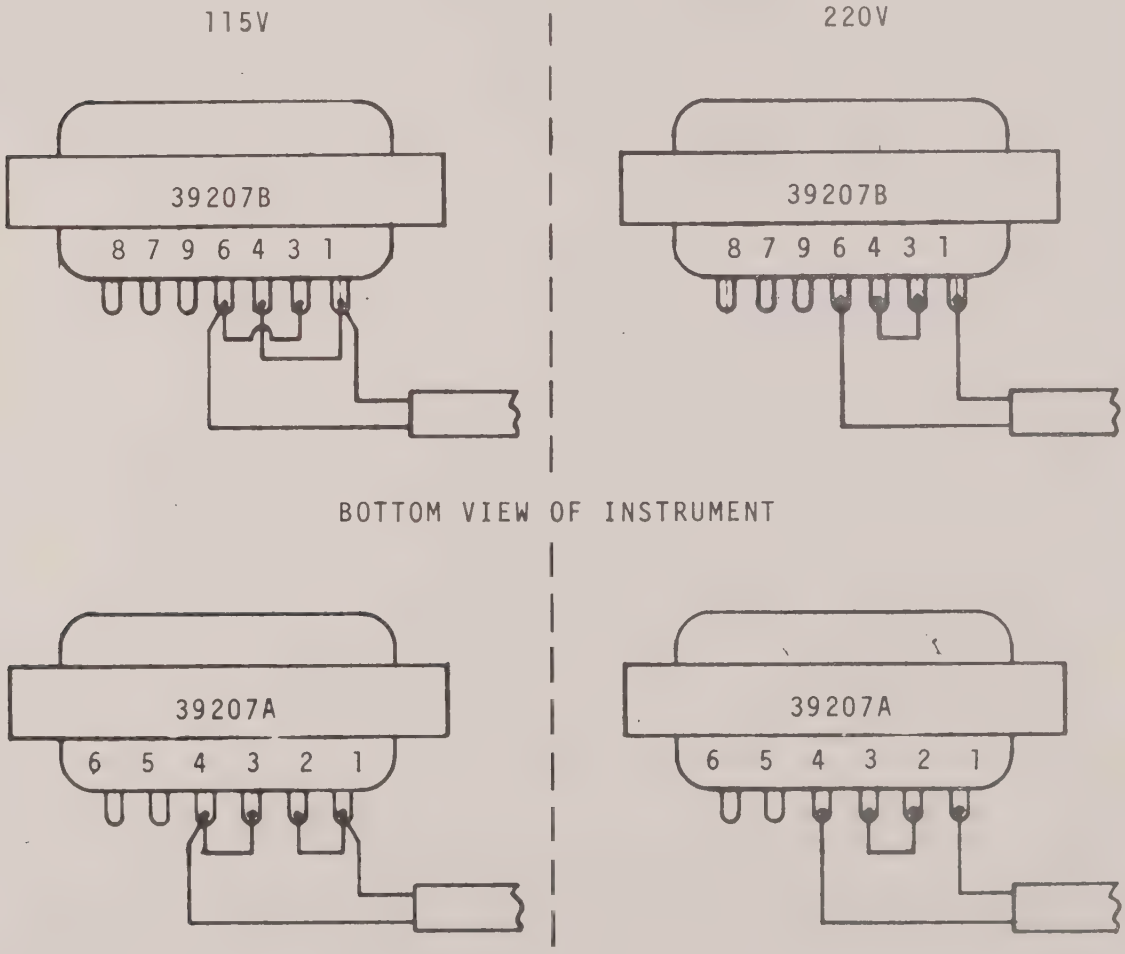



FIGURE 2.1 TRANSFORMER JUMPER POSITION FOR POWER CHANGE

# CHAPTER 3
# OPERATION

## 3 1 INTRODUCTION

This section describes the SD Model 6053/3 controls, connectors, and indicators. Initial turn-on and operational checks are included, along with step-by-step operating procedures listing each basic function of the counter.

## 3 2 CONTROLS, CONNECTORS, AND INDICATORS

Figures 3.1 and 3.2 illustrate the Model 6053/3 front and rear panel controls, connectors, and indicators. Table 3.1 and 3.2 provide a description of these functions.

TABLE 3.1 FRONT PANEL

| FIGURE | INDEX | NAME | | FUNCTIONS |
|---|---|---|---|---|
| 3.1 | 1 | POWER (pushbutton) | | Applies power to the instrument. |
| 3.1 | 2 | TEST (pushbutton) | | Applies the 1MHz internal oscillator frequency to the internal circuits for test. |
| 3.1 | 3 | RANGE .2 - 3GHz (pushbutton) | | Activates "N" connector (see Index 11) for input of .2-3GHz. |
| 3.1 | 4 | RANGE 20Hz - .2GHz ATTENUATOR (pushbuttons) | X1<br>X10<br>X100<br>X1k | Attenuates the input applied to the 1MΩ, 20Hz - .2GHz BNC connector by a factor of 1 (X1), 10 (X10), 100 (X100), and 1000 (X1k). |
| 3.1 | 5 | DISPLAY (indicator) | | Digital indicators and polarized window provide glare-free viewing of measurement. |
| 3.1 | 6 | 20Hz - .2GHz 1MΩ (connector) | | Type BNC provides signal input connection for the 20Hz - .2GHz range of measurement |

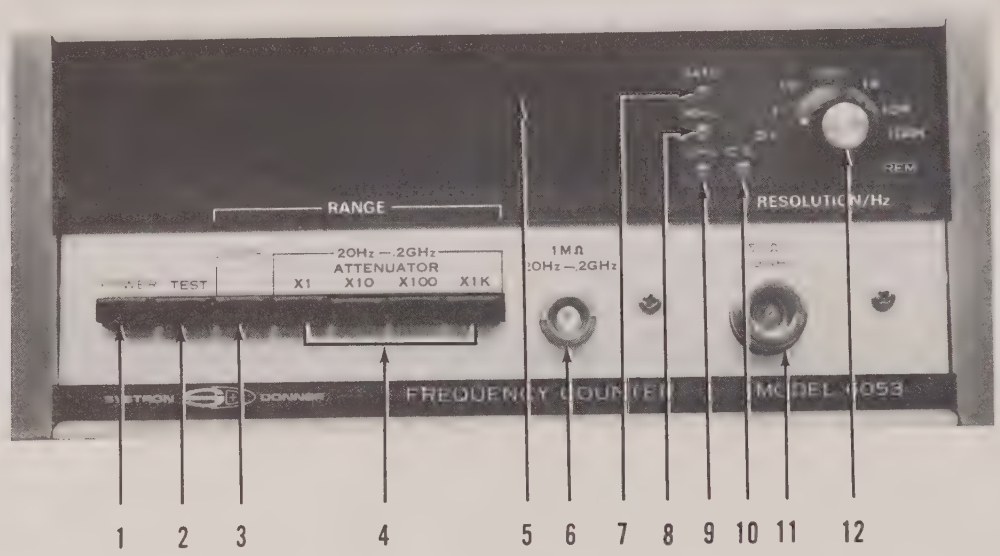



FIGURE 3.1 FRONT PANEL, MODEL 6053/3

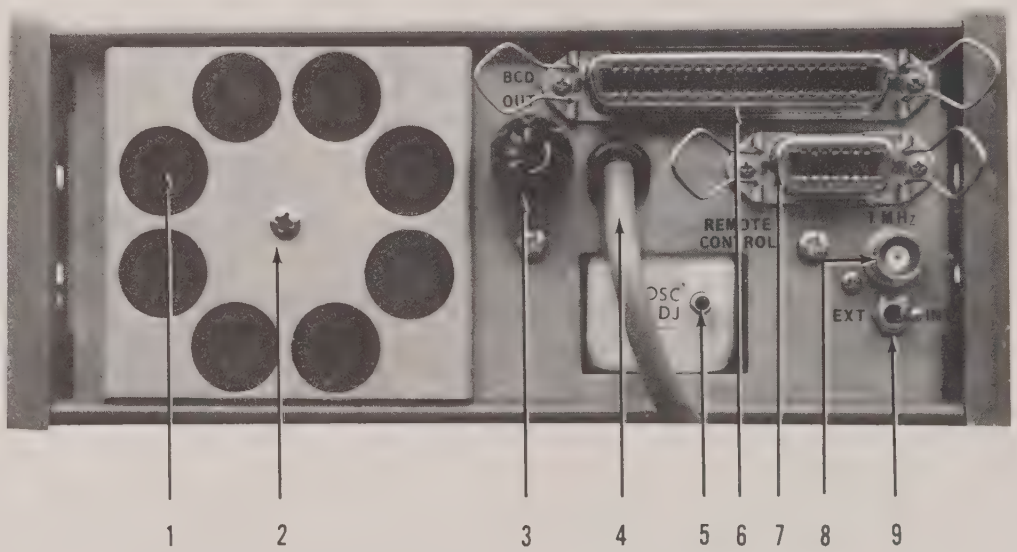



FIGURE 3.2 REAR PANEL, MODEL 6053/3

TABLE 3.1 FRONT PANEL (Cont'd)

| FIGURE | INDEX | NAME | | FUNCTIONS |
|---|---|---|---|---|
| 3.1 | 7 | GATE (indicator) | | Light-emitting diode (LED) indicates when the count gate is open or closed. |
| 3.1 | 8 | MHz (indicator) | | Light-emitting diode (LED) when energized, indicates that readout units are in MHz. |
| 3.1 | 9 | GHz (indicator) | | Light-emitting diode (LED) when energized, indicates that readout units are in GHz. |
| 3.1 | 10 | O.S. (indicator) | | Light-emitting diode (LED) when energized, indicates that a reading is off-scale. |
| 3.1 | 11 | .2 - 3GHz 50Ω (connector) | | Type N connector provides signal input connection for .2 - 3GHz. |
| 3.1 | 12 | RESOLUTION/Hz (switch) | $10^{-1}$, 1, 10, $10^{2}$, $10^{3}$, $10^{4}$, $10^{5}$, REM. | Switch provides 7 ranges of resolution and a remote position for programmable operation. |

TABLE 3.2 REAR PANEL

| FIGURE | INDEX | NAME | FUNCTION |
|---|---|---|---|
| 3.2 | 1 | FAN INTAKE | Air intake for cooling. |
| 3.2 | 2 | FAN SCREEN | Screens dust and particulate matter from cooling air (should be cleaned weekly). |
| 3.2 | 3 | FUSE HOLDER | Retains power fuse. |
| 3.2 | 4 | POWER CORD | 3-conductor grounded power cord. |

TABLE 3.2 REAR PANEL (Cont'd)

| FIGURE | INDEX | NAME | | FUNCTION |
|---|---|---|---|---|
| 3.2 | 5 | 1MHz OSCILLATOR (controls) | Coarse<br>Fine | Adjusts the internal 1MHz oscillator frequency. |
| 3.2 | 6 | BCD OUT (optional connector) | | Provides BCD information compatible with IC logic. |
| 3.2 | 7 | REMOTE CONTROL (optional connector) | | Permits remote operation of attenuator and all front panel controls. |
| 3.2 | 8 | 1MHz (connector) | | Provides 1MHz out when INT/EXT switch is in INT position. Provides input for external 1MHz signal when INT/EXT switch is in EXT position. |
| 3.2 | 9 | INT/EXT (switch) | | Provides selection of internal or external time base. |

## 3.3 INITIAL TURN-ON AND OPERATIONAL CHECK

The following procedures verify operation of the Model 6053/3 prior to on-line usage. Successful completion of these checks should precede any performance tests.

1. Connect power cord to 115V ac source.

*CAUTION*

*Be sure transformer is wired for 115V operation (see Section 2.3.1).*

2. Position INT/EXT switch (Index 9, Figure 3.2) to INT.
3. Press POWER pushbutton to ON (Index 1, Figure 3.1).
4. Press TEST pushbutton to ON (Index 2, Figure 3.1).
5. Check instrument readout (Table 3.3) while turning RESOLUTION/Hz switch through the (7) selectable ranges.

TABLE 3.3 CHECK, IN TEST

| RESOLUTION/Hz SWITCH POSITION | READOUT INDICATION |
|---|---|
| $10^{-}$ | XX.0000000 MHz (O.S.) |
| 1 | XX1.000000 MHz |
| 10 | XX01.00000 MHz |
| $10^{2}$ | XX001.0000 MHz |
| $10^{3}$ | XX0.001000 GHz |
| $10^{4}$ | XX00.00100 GHz |
| $10^{5}$ | XX000.0010 GHz |
| REMOTE | Same as above |

XX - Additional digits available, E and EE Options

## 3.4 OPERATING PROCEDURES

The following procedures outline the general method for operating the Model 6053/3 in the two measurement ranges.

### 3.4.1 General

Operation is fully automatic and requires no special adjustments.

### 3.4.2 20Hz - .2GHz RANGE

1) Press POWER pushbutton to ON.
2) Press proper attenuator pushbutton in accordance with input level. If input level is unknown, select highest attenuation level (X1k) first; then, proceed to select lower attenuation levels (X100, X10, or X1) to obtain consistent count readings.
3) Apply 20Hz - .2GHz signal to 1MΩ Type BNC connector.
4) Select desired readout resolution.
5) Measurement is automatic.

### 3.4,3 2 - 3GHz RANGE

1) Press POWER pushbutton to ON
2) Press 2 - 3GHz pushbutton

3) Apply .2 - 3 GHz signal to 50 Ω Type N connector.

4) Select desired readout resolution.

5) Measurement is automatic.

### 3.4.4 Turn-off Procedures

1) Press POWER pushbutton to OFF.

2) Disconnect power cord from ac source.

*NOTE*

*Do not disconnect power cord from ac source if B, B3, or B4 Oscillator Option is installed. (Crystal oven must remain energized at all times to ensure high-accuracy readout operation.)*

# CHAPTER 4
# THEORY OF OPERATION

## 4.1 INTRODUCTION

Included in this chapter are the general theory and circuit descriptions of the Model 6053 Counter. A general block diagram, along with a timing diagram, are included for reference. Schematics will be found in Chapter 6.

## 4.2 GENERAL THEORY

The Automatic Computing Transfer Oscillator (ACTO) operates by phase-locking a low frequency oscillator to the applied RF input frequency and computing the harmonic multiple "N". The counter time base is then expanded such that the counter will count the low frequency oscillator for a period equal to "N" times the selected time base. The result is a direct indication of the RF input frequency. Figure 4.1 depicts the basic block diagram for the ACTO. As illustrated, the phase-lock loop incorporates a harmonic phase detector, amplifier search oscillator, and a voltage-controlled oscillator. The free-running search oscillator sweeps the voltage-controlled oscillator over a narrow band of frequencies, producing an output varying in frequency between 17.5 and 19.5MHz. This signal is applied to the harmonic phase detector and is phase-compared to the RF input. When an exact oscillator harmonic is encountered, a dc voltage is generated which disables the sweep oscillator and locks the voltage-controlled oscillator to a sub-multiple of the input frequency.

Since the harmonic number (N) is unknown, it is not possible to measure the exact input frequency. Therefore, a second output from the voltage-controlled oscillator is extracted and applied to a single-sideband generator. The generator is modulated at a 1kHz rate resulting in an output equal to the oscillator's frequency shifted by 1kHz. This signal is now applied to a harmonic phase detector, the output of which is equal to 1kHz x N.

Since the original 1kHz modulation frequency and the 1kHz x N are present, it is possible to compare the two frequencies digitally and extract the corresponding harmonic number (N). This is the function of the N compute and control circuit. Having extracted N, the N compute and control circuit expands the time base period by the appropriate factor of N to provide a direct readout of the input frequency.

## 4.3 CIRCUIT DESCRIPTIONS

### 4.3.1 POWER SUPPLY (Schematic C39082)

The Model 6053 power supply provides both regulated and unregulated voltages from either a 115V or 230V, 50 to 60Hz source.

Primary power arrives at the primary windings of power transformer T1 from the ac line cord, through a line filter, fuse F1, and a POWER/ON switch S1. The power transformer provides three separate secondary windings from which the following voltages are obtained: +225V dc (indicator tubes), +5V dc (logic), and ±15V dc (bias). A special ACTO +5V dc and -5.2V dc are provided with additional circuitry.

+225 Supply (unregulated)

The +225V supply voltage is produced in the following manner: approximately 175V rms from the T1 secondary winding, 5-6 is half-wave rectified by CR5. The resultant voltage is distributed to the indicator tube circuitry on the Readout Board via pin E30.

+15V Supply (regulated)

The regulated +15V supply is based on 35V rms from the center-tapped secondary winding, 10-11-12. A full-wave bridge rectifier, CR1-CR4, and filter capacitor C2 produce a +22 volt dc potential which is applied to the integrated circuit regulator, U1. The regulated +15V output is then controlled by the series pass transistor Q1, permitting about 300mA maximum current at pins E19-E21.

-15V Supply (regulated)

The regulated -15V supply is based on 35V rms from the center-tapped secondary winding, 10-11-12, and referenced to the +15V regulated supply. The -22 volt dc potential, filtered by C3, is fed through R8 and pass transistor Q4 to the differential amplifier Q2 and Q3. This amplifier keeps the junction of R7 and R9 at 0 potential.

Since R7 and R9 are equal, the voltage drop across each is the same. Thus, if R2 adjusts the +15V supply, the -15 volts across R9 will track. 300mA is available at pins E26-E28.

+5V Supply (regulated)

From secondary winding 7-8-9 of T1 and the full-wave bridge, CR6-CR9, a +9V potential is fed to IC regulator U2. The resulting regulated +5Vis then passed by Q9, providing about 1.35A of current at E24-E25.

-5.2V Supply (regulated)

From secondary winding 7-8-9 of T1 and the full-wave bridge, a -9V potential is fed to buffer amplifier Q7 and Q8; then, the differential amplifier Q5 and Q6 which references the resulting -5.2Vwith the regulated +5V supply.

ACTO +5 (regulated)

This supply is referenced to the +15 volt supply by the differential pair contained in U3 and adjusted by R17. The pass transistor Q11 allows 2.0A maximum at E22-E23. E29 is the ACTO enable line which enables Q10 when the ACTO line is grounded, turning on U3.

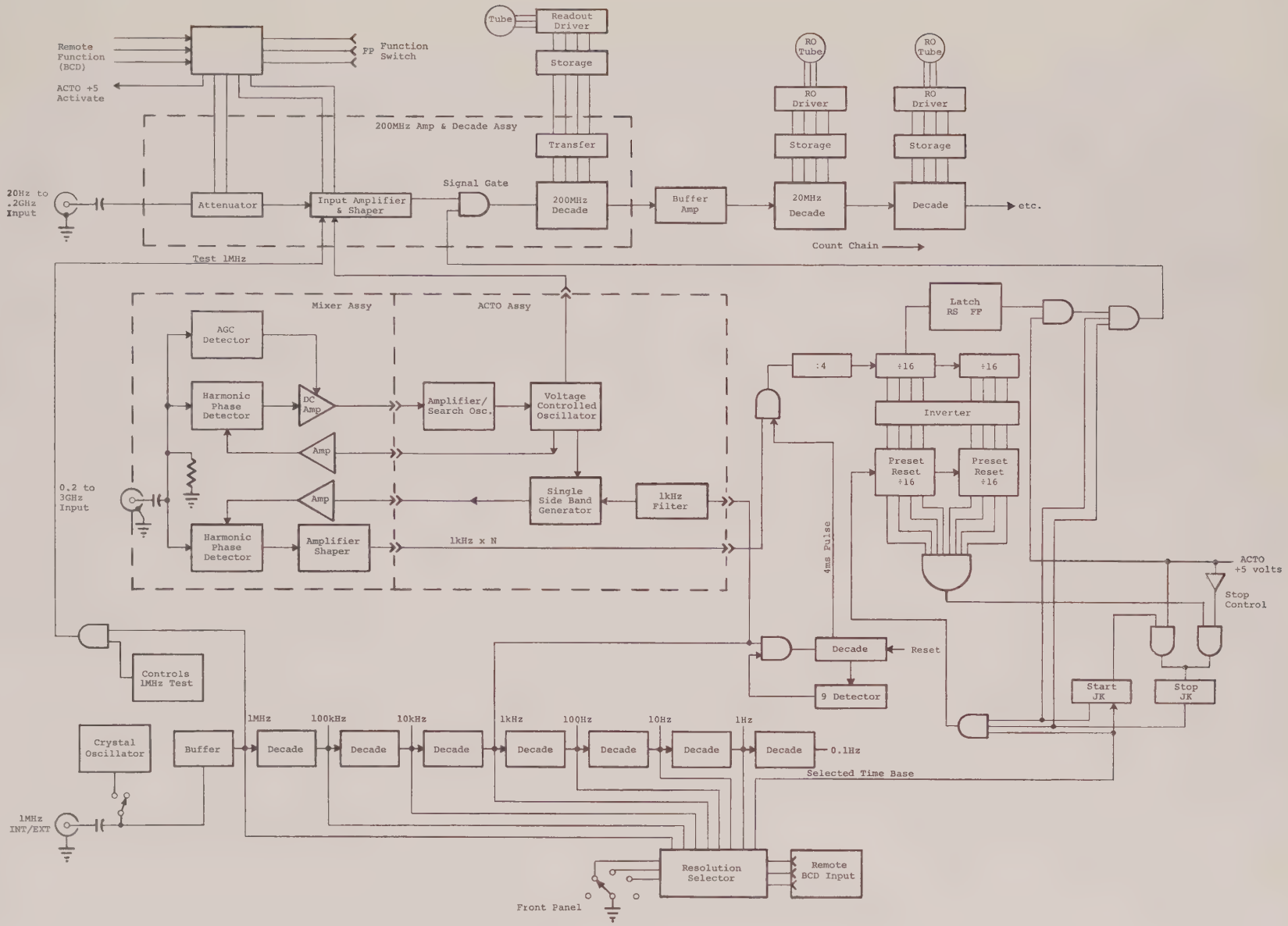



FIGURE 4.1 MODEL 6053/3 BLOCK DIAGRAM

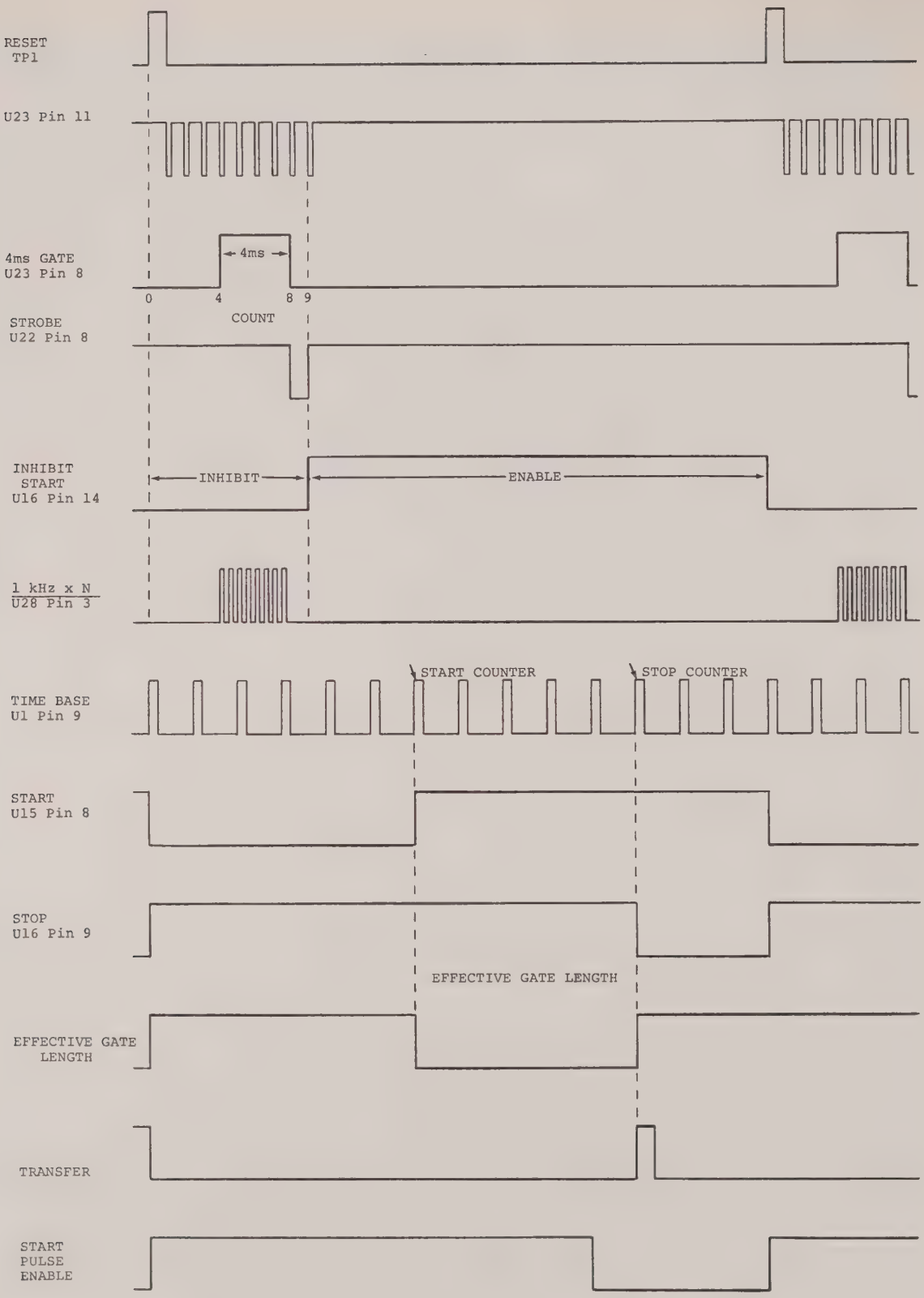



FIGURE 4.2 TIMING DIAGRAM, MODEL 6053/3

4.3.2 A2, SHIELD BOARD (Schematic D39100)

This circuit selects the various functions by pushbuttons located on the front panel. Refer to the Interconnect Diagram in Chapter 6.

4.3.3 A3, COUNTER READOUT ASSEMBLY (Schematic D33997, Pages 1 & 2)

Included on this assembly are:

1. The time base count chain.
2. The resolution and function logic, both for internal and external BCD control.
3. The signal gate control circuitry.
4. The Count Chain.
5. The ACTO "N" computer circuitry.

1. Time Base Count Chain

The internal 1MHz time base is applied to the count chain at terminal E42. This time base is derived from either an internal 6053 crystal-controlled oscillator or from an external standard.

It is first shaped by the Schmitt trigger Q1 and Q2; then, translated to TTL logic levels by Q3. It then drives U2 pin 14, the first decade in the counting chain. It is followed by U3, U4, U5, U6, U7, and U8, the remainder of the time base decades.

2. Resolution And Function Logic

The outputs of the time base dividers become seven inputs of the two data selectors U1 and U9. Pins 9, 10, and 11 of these data selectors control, by BCD logic, which of the seven input time base frequencies will appear at U1 pin 5 as the selected time base frequency.

U1 normally selects the time base frequency and is BCD controlled by the 6053 front panel resolution switch. When this switch is turned to the remote position, however, it selects the eighth input, U1 pin 1 which is connected to the output of U9. U9, in turn, is controlled externally through its BCD inputs which connect to the remote control connector.

The following logic levels appear at the specified pins of the resolution switch giving both internal and remote switch positions

TABLE 4.1 LOGIC STATES

| Internal Pins | E4 | | E8 | E9 | | |
|---|---|---|---|---|---|---|
| Remote Pins | E37 | | E39 | E41 | Decimal Point Position | Binary Number |
| Remote | 0 | | 1 | 1 | - | 3 |
| 100 kHz | 0 | GHz | 0 | 0 | 4 | 0 |
| 10 kHz | 0 | GHz | 0 | 1 | 5 | 1 |
| 1 kHz | 0 | GHz | 1 | 0 | 6 | 2 |
| 100 Hz | 1 | MHz | 0 | 0 | 4 | 4 |
| 10 Hz | 1 | MHz | 0 | 1 | 5 | 5 |
| 1 Hz | 1 | MHz | 1 | 0 | 6 | 6 |
| 0.1 Hz | 1 | MHz | 1 | 1 | 7 | 7 |

The logic level at J5 if it is in the 1 state, drives U14 pins 1, 2 and 4 to the 1 state. Pin 3 of U15 goes to 0 and pin 6 of U15 goes to a 1 state. Pin 6 of U14 then goes to a 0 state turning Q6 off, extinguishing the GHz lamp and turning Q7 on; thus, supplying current to the MHz lamp.

A 0 at J5 has the opposite effect. By the presence of a 0 at U14 pin 4, U14 pin 6 is driven to a 1 state turning Q6 on, supplying current to the GHz lamp, turning Q7 off, extinguishing the MHz lamp.

Decimal Point

There are three decimal points in the GHz range and four decimal points in the MHz range. As seen from the chart they are positions 4, 5, 6, and 7. They are,with the exception of number 7, the same in the MHz range and in the GHz range. The decimal points are located in the display tubes and are switched by U29, a 4 to 10-line converter. The logic levels at the inputs of U29 are:

| Tube | A | B | C | D |
|---|---|---|---|---|
| 4 | 0 | 0 | 1 | 0 |
| 5 | 1 | 0 | 1 | 0 |
| 6 | 0 | 0 | 1 | 0 |
| 7 | 1 | 1 | 1 | 0 |

Since the logic levels in the C and D columns do not change they are permanently wired to the 1 and 0 logic levels. The logic levels at A and B are obtained from the terminal lugs, J3, J4 and are inverted by the two gate functions of U10, driving the 4 to 10-line converter U29 which lights the correct decimal point.

When the resolution switch is in the remote position, the decimal point logic is supplied to the external rear panel connector J5 through the other two gating elements of U10.

Function Switch

The front panel function switch is a set of six pushbuttons which supply BCD information to three sections of the quad gate U11. When the resolution switch is in "Remote", the 6053 functions are controlled by BCD from rear panel connector J5, operating the three sections of the Quad gate U12. The functions and BCD information required at lugs E31, E38, and E36; E33, E28, and E29 respectively are as follows:

TABLE 4.2 FUNCTION BCD

| Remote | E33 | E28 | E29 |
|---|---|---|---|
| Front Panel Control | E31 | E38 | E36 |
| Test | 1 | 0 | 0 |
| Hi Frequency | 0 | 0 | 0 |
| X1 | 1 | 1 | 1 |
| X10 | 0 | 1 | 1 |
| X100 | 1 | 0 | 1 |
| X1k | 0 | 0 | 1 |

3. Signal Gate Control

The unijunction transistor Q13 fires developing a positive pulse at base 1. This is amplified and inverted by Q14 and turns Q15 off for the duration of the pulse. The positive pulse at the collector of Q15 resets all the counting decades, the 1Hz and 0.1Hz time base decades, as well as U26, U27, and U23. The positive pulse is inverted by U25 and then resets U16, U30; it is also available at pin E24.

U23, a decade counter, is normally driven by 1kHz from U4, a time base divider, through the gate function U17. It will count the 1kHz until the decade reaches the count of nine, at which time it drives the two input pins 4 and 5 of U22 to the 1 state. Pin 6 of U22 then becomes a 0 and disables U17, preventing any more 1kHz pulses from reaching the input of U23. Pin 6 of U22 is inverted by U18. Pin 8 of U18 then becomes an inhibit-start signal for the stop flip-flop U16 by holding the J line, pin 14, of U16

down in the 0 state. Pin 12 had been set to the 1 state by the negative reset pulse at pin 6 and pin 2.

The dual JK flip-flop U16 is initially reset with pin 12 and pin 9 in the logical 0 state. (Low voltage state.) The voltage at pin 13 ($\overline{Q}$) is in the 1 state and is inverted by U17 to cause J (pin 7) to be in the 0 state preventing pin 8 (Q) from being driven.

Upon receipt of one of the time base pulses at pins 1 and 5, pin 12 is driven to the 1 state which permits the 6053 signal gate to open. At the same time pin 13 goes to the 0 state and after being inverted by U17, brings pin 7 (J input) to the 1 state.

The next time base pulse arriving at pins 1 and 5 cannot drive the left-hand flip-flop because pin 3 (K) is held in the 0 state and inhibits the flip-flop.

The time base does drive the right hand flip-flop (pin 5) causing pin 8 ($\overline{Q}$) to be in the 0 state. Pin 10 (J) is grounded so no further inputs will be accepted. Pin 8 now inhibits the signal gate and the 6053 count chain no longer has an input.

Transfer Pulse

When the right-hand flip-flop in U16 is driven, Q (pin 9) is driven to the 1 state. This is inverted by the gate function U11 after which it is differentiated by C4 and R24. It passes through CR2 and turns off Q10. A positive pulse appears at the collector of Q10 which transfers the BCD information contained in the count decades to the SN7475 storage packs.

The stored BCD now contained in the SN7475's is converted to 10 line information and drives the gas display tubes V1 thru V9.

Reset

Pin 8 of U16 is coupled thru R27 to the base of Q12. At the end of the count period Q12 turns off. C5 is then permitted to begin charging to +15V thru R33. When it reaches about +7V the uni-junction transistor Q13 fires, discharging C5 to ground. A positive pulse is developed across R29 and coupled through R30 to the base of Q14. A reset pulse is generated which drives pin 8 of U16 positive, causing Q12 to turn on and clamp C5 to ground. Now the whole cycle repeats.

4. Count Chain

The count chain consists of U35, U38, U41, U44, U47, U50, U53, and U56. U35 is a SN7490, the remainder are SN7090 decades. The first decade in the count chain is not on the read-out board, but instead, is a separate assembly. In the 6053 the first decade is capable of counting up to 200MHz. The input amplifier and signal gating circuits are included on the separate Amp and Decade assembly.

The output of the first decade comes into the Readout Board at E18 and E19. The signal is amplified by Q4 and Q5; then, drives the input (pin 14) of U35. Pin H of U35 couples to pin 14 of U38, and so on.

The BCD information enters the Readout Board at lugs E11, E12, E13, and E17 where it is stored in U32. The output of U32, when strobed by the control circuitry on pins 4 and 13, is translated to 10-line by U31 (SN7441). The output of U31 grounds one of the ten cathodes at the gas display tube V1 causing a number to glow.

The remaining storage packs (SN7475) are U34, U37, U40, U43, U46, U49, U52, and U55, and operate in the same manner.

5. ACTO Computer

The ACTO N computer causes the time base period selected by the front panel resolution switch to be expanded by some factor. Typically that factor will be the harmonic number "N".

When the 0.2-3GHz button is depressed, lug E30 goes to near ground which enables the ACTO +5V power supply. The ACTO +5V enters the readout board at E44. It enables U17 pin 4 and, after being inverted by U18 pin 10 and 11, inhibits U17 pin 1. The effect of this is to prevent the stop flip-flop (U16 pin 9) from being driven until U19 pin 8 goes to the 0 state.

As shown in the timing diagram, the sequence of operation is inhibited by the reset pulse. The decade U23 is first reset to zero; then, counts the 1kHz pulses until it reaches the count of nine, at which time, U17 becomes disabled and the decade counts no further until the next reset pulse.

When the decade (U23) reaches the count of four, pin 8 goes to the 1 state. This enables the gate U12 and raises the JK lines of U28, a dual JK flip-flop, to the 1 state. 1kHz x N pulses are then divided by four in U28. The (1kHz x N) ÷ 4 is then counted by the two cascaded divide-by-16 counters U26 and U27 until U23 reaches the count of 8. At this time U12 is disabled and the JK lines of U28 are grounded. Since (1kHz x N) ÷ 4 has been counted for four periods of 1kHz, N counts will be counted. When U23 reaches the count of 8, pin 1 of U20 and U21 go to the 0 state and return to the 1 state when U23 reaches the count of nine.

When strobed by a negative pulse on pin 1, the integrated divide-by-sixteen counters U20 and U21 are reset to the condition set up by the BCD inputs on pins 4, 10, 3, and 11.

The information contained in U26 and U27 is inverted so that a compliment of the BCD information is applied to the BCD input lines of U20 and U21.

If the number N is 34 then the compliment would be the full capacity of the two divide-by-16 counters minus 34.

When the decade reaches the count of nine, U16 pin 14 goes to the 1 state permitting a start pulse to be accepted. U15 pin 8 goes to the zero state. U15 pins 1, 2, 12, and 13 become enabled permitting the time base pulses to pass through U15 to pin 8 of U20. U20 and U21 then continue to count the time base pulses, triggering on the trailing edge of the pulses. When U20 and U21 reach the condition 1111 or full capacity, pin 8 of U19 goes to the

zero state. This occurs on the trailing edge of a timing pulse. This is inverted by U17 pin 4, 5, and 6 and enables pin 7 of U16 which permits the leading edge of the time base to drive the stop JK flip-flop. Pin 8 of U16 is driven to the zero state and inhibits U15. The preset divide-by-sixteen counters U20 and U21 no longer count the time base.

During the time that the ÷16 preset-reset counters are counting the time base, U15 pin 8, the start line, and U16 pin 9, the stop line are both near ground in the zero state. During this time the counting decades are counting the ACTO VCO frequency.

If N = 100 and the ACTO VCO frequency = 19MHz, then the input frequency is 1900.0MHz or 1.9GHz and will be displayed by the 6053 readout tubes.

### 4.3.4 200MHz AMP AND DECADE (Schematic D39095)

The 200MHz Amp and Decade circuit description consists of the following sections:

1. X100 Input Attenuator.
2. High input impedance, gain-controlled input stage.
3. Two stages of grounded emitter and two stages of emitter follower amplifier.
4. Schmitt trigger.
5. Signal Gate.
6. 200MHz MECL decade counts with translator to provide TTL BCD logic level output.

The input to the 200MHz Amp and Decade is capacitor-coupled to the input attenuator. This attenuator is controlled by a relay and has an attenuation factor of X1 or X100.

The output of the attenuator is applied to gate 1 of the MOS transistor Q2. This transistor has a voltage gain of 2 or 0.2 and is controlled by the bias on gate 2.

An emitter follower Q3 dc couples this stage to the wide-band amplifier Q5, Q6, Q7, and Q8.

The output of Q8 is applied to the input of the Schmitt trigger, Q9-Q12. The operational amplifier U1, by comparing the dc voltage at the input to the Schmitt trigger, and the voltage at the trigger level pot (R47), adjusts the bias at the base of Q1 to cause the two voltages to become equal.

Two other inputs are provided for the amplifier circuit. One on J2-4 accepts the 1MHz test frequency provided in the 6053. The other, J4 accepts the 20MHz oscillator frequency from the ACTO. When either of these two inputs are used Q2 is turned off by reverse biasing gate 2, thus disabling the normal input.

The Schmitt trigger Q9, Q10, Q11, and Q12 is a conventional high-speed circuit. The input is applied to the base of transistor Q9 which drives emitter follower Q11; then, transistor Q10. The output from Q10 is coupled to the signal gate U2 pin 4 by emitter follower Q12.

The signal gate is turned on and off by applying a voltage at J2-9 and J2-8. A positive (+5V) disables the gate and a ground at these points.

The decade consists of four MECL Flip-Flops U3, U4, U5, and U6. The output of the decade is buffered by the second half of U2 and goes out on J2-5 and J2-6. The MECL BCD logic levels are translated to TTL logic levels by the translator U7.

### 4.3.5 A5, ACTO (Schematic C39087)

The search oscillator generates the triangular waveform that sweeps the voltage-controlled oscillator (VCO). Transistors Q1 and Q2 form a binary switch. In the following example, with no input, (or with gain potentiometer R24 turned fully counter clockwise) Q1 conducts and Q2 is held "off". Current flows from the -5.2 volt supply, through Q1 and R9 into the input of amplifier U1 (pin 2). U1 inverts and, due to the feedback network (C2, R5) produces a linear rise in voltage at the output (pin 6). When the output voltage reaches +10V (15 volt difference of potential), CR1 conducts, forward biasing Q2. Q2 now conducts while Q1 is held "off". This action causes the amplifier (U1) to draw current from the positive supply through R12, driving the output in a negative direction until it reaches -5 volts. At -5 volts, Q2 is turned "off" and Q1 is turned "on", repeating the cycle. The net effect is a triangular waveform varying between +10 and -5 volts (TP1).

Voltage-Controlled Oscillator ACTO

The triangular waveform is now applied to the base of emitter follower Q3, and into the voltage-controlled oscillator's (VCO) frequency determining tank circuit (CR3, CR4, and L2). CR3 and CR4 are "varicap" type diodes whose capacitance is inversely proportional to the bias applied.

Note that, the varicap curve is nonlinear. To compensate for this nonlinearity, corrective networks consisting of a resistor and a diode in series (R6, CR2, and R3, CR8) are placed across the triangular wave generator load resistor (R15). The effect of these two networks is a nonlinear curve which opposes the varicap curve, resulting in a more linear function.

Single-Sideband Generator

The output from the VCO must be shifted in frequency by 1kHz in order to properly drive the "N" channel harmonic mixer, and must be sinusoidal to drive the single-sideband generator.

The VCO signal is obtained from the emitter of Q5, filtered by R23, C31, L6 and C32 to reduce harmonic distortion, and is then split into two components, separated in phase by 90°. Phase separation is accomplished by an LR phase lag circuit (L7, R50) and CR phase lead circuit (C19, R49). The resultant signals are used to drive balanced modulators (U2).

Simultaneously, a 1kHz signal from the time base is routed to the base of Q10. Transistor Q10 inverts and amplifies the signal. A "twin T notch filter" on the collector of Q10 is tuned to block 1kHz, passing all other frequencies. Q11 FET transistor provides a negative feedback path for all frequencies except

1kHz. The remaining 1kHz signal, at the collector of Q11, is now capacitively coupled to the base of phase-splitting amplifier Q8. Two separate 1kHz signals, 90° out-of-phase, are extracted from Q8: The non-inverted signal from the emitter circuit and the 90° leading signal from the emitter of Q9. These signals are capacitively coupled to the balanced modulators in U2. The first balanced modulator removes the carrier frequency, and the second modulator removes one sideband resulting in a single-sideband signal. The net effect of this action is the shifting of the carrier frequency by 1kHz. The balanced modulators (U2) are a pair of differential amplifiers utilizing the carrier to drive the common mode inputs. U3 sums the outputs of the balanced modulators and converts them to a single output.

### 4.3.6 A6, ACTO MIXER/DRIVER (Schematic C27988)

The mixer/driver assembly consists of two sampling-type mixers, including the local oscillator drive circuits and output amplifiers.

The output of the ACTO VCO is applied to terminal A on the Driver Amp. It is amplified by the differential amplifier/limiter Q101 and Q102. With signal applied, Q105 emitter follower in turn drives the anode of step recovery diode CR101 positive, charging capacitor C107. When the voltage tries to reverse, the diode CR101 continues to conduct for a time. When it finally reverses, it does so very abruptly. Since all of the current through CR101 has been passing through the printed circuit inductors a voltage transient develops when the current is no longer available. A negative pulse is formed at the anode of CR101 and a positive pulse at the cathode of CR101. These two pulses are approximately 1.2 volts in amplitude and 0.5nsec in width at the base line. They are coupled through C101, X1, P1, and C102, X2, P2 to the mixer P.C. Assy.

This has been a description of the lock channel driver. The N channel driver (Q103, Q104, and CR106) operates in exactly the same manner.

Sampling Bridge

The negative pulse from P1 is terminated in R1; then, coupled through C1 to the cathode of CR2.

The positive pulse from P2 is terminated in R2; then, coupled through C2 to the anode at CR1. CR1 and CR2 detect these pulses and set up a positive 0.7 volt bias on the cathode of CR2 and negative bias on the anode of CR1. The voltage at the junction of R5 and R6 is nominally zero volts dc.

The second sampling bridge CR3, CR4, R7, and R8 operates identical to the first.

The RF input signal (200MHz to 3GHz) is applied to the input of both sampling bridges (junction of CR1, CR2, and junction of CR3, CR4). It is then terminated into R9,a 50Ω chip resistor.

The output of the lock phase detector bridge is amplified by U1, an operational amplifier. The dual FET Q1 is used as source followers to reduce the signal input current requirement by the amplifier. The output of the amplifier is present at lug "C" on the mixer P.C. board.

To improve the dynamic range of the ACTO and the overload characteristic, an AGC system is used.

CR5 is used as an AGC Detector and detects the level of RF applied to the input of the instrument. The dc voltage drop across CR5 is cancelled out by an opposing voltage drop across CR6. The detected dc voltage is then amplified by the operational amplifier U2. A negative voltage is developed on the output of this amplifier and biases Q3, an N channel FET. $Q^3$ is used as a voltage-controlled resistor which, by altering the negative feed-back, controls the gain of the lock channel amplifier U1.

The dc feed-back network around U2 is designed to have a nonlinear gain curve which matches the voltage to resistance curve of Q3. Potentiometer R19 determines the AGC operating threshold voltage. The output of U1 on the Mixer P.C. Board goes out to lug "C"; then, through the connecting cable to pin 14 of J2 on the ACTO assembly. There it connects to the input of U1, the search oscillator/ amplifier.

When in a phase lock condition, a voltage appears at pin 14, J2 which cancels the current supplied by R9 to pin 2 of U1. Then the search oscillator is over-powered and U1 becomes simply an amplifier.

The N channel amplifier/shaper consists of Q2 and U3. Q2 is a source follower which presents a high impedance load to the N channel phase detector (actually used as a mixer).

Transistor Q2 is followed by an emitter follower; then, a grounded base stage. The output of the grounded base stage drives the Schmitt trigger. The shaped output from the Schmitt trigger drives the grounded emitter amplifier. This last amplifier provides square waves at terminal "X",at TTL logic levels. All the amplifying and shaping is done with five transistors in U3,a transistor array.

The signal at terminal "X" is 1kHz x N. The input of the Schmitt trigger (pin 4 of U3) goes to a lug TP1 and is available as 1kHz x N prior to shaping.

NOTES

# CHAPTER 5
# CALIBRATION-MAINTENANCE

## 5.1 INTRODUCTION

This chapter is devoted to maintaining the factory-new performance of the Model 6053 Counter. A calibration procedure, acceptance test and troubleshooting guide have been included for this purpose.

## 5.2 FACTORY SERVICE

Whenever the instrument requires service, other than normal calibration, the nearest Systron-Donner representative should be contacted. He can provide field service or arranqe factory service when necessary. Address all inquires on operation or application to your nearest sales representative, or to:

Sales Manager-Concord Instrument Division
Systron-Donner Corporation
888 Galindo Street
Concord, California 94520

*Be sure to specify the complete model and serial number in all correspondence.*

## 5.3 PART LOCATION

Printed circuit board outline drawings and related parts lists have been included in Chapter 6 to facilitate part identification and location.

## 5.4 CALIBRATION PROCEDURE

The following test equipment is required for calibration and adjustments:

| | | |
|---|---|---|
| (1) Oscilloscope | Tektronix | Model 581 A or equiv. |
| (2) Voltmeter | Systron-Donner | Model 9000 or equiv. |
| (3) Voltmeter | Simpson | Model 260 or equiv. |
| (4) 1MHz frequency standard; 1 part in $10^{-10}$ short term. | | |
| (5) Signal Generator | H.P. | Model 608 E or equiv. |
| (6) RF Voltmeter | H.P. | Model 411 A or equiv. |

### 5.4.1 Power Supply Adjustments (Schematic C39082)

The following chart indicates the proper supply voltages and their associated adjustment controls. All are located on the Power Supply P.C. Assembly. The SD 9000 DVM is used for these measurements.

TABLE 5.1 POWER SUPPLY ADJUSTMENT

| LOCATION | VOLTAGE | | TOLERANCE |
|---|---|---|---|
| E20 | +15.00 | R2 +15 adjust | ±.10Vdc |
| E24 | +5.00 | R4 +15 adjust | ±0.01Vdc |
| E31 | -5.20 | R13 -5.2 adjust | ±0.01Vdc |
| E27 | -15.00 | None (R2 +15 adjust) | ±1Vdc |
| E22 | +5.00 | R17 ACTO +5 adjust | ±0.01Vdc (The 0.2-3GHz pushbutton must be depressed.) |
| E30 | +225 | None | +80 ±10Vdc as read with the Simpson 260. Voltage is 225V peak but is half-wave rectified, and unfiltered. This accounts for the low voltage reading. |

### 5.4.2 Oscillator Adjustment

Push on TEST pushbutton. Place 1MHz INT/EXT switch to INTernal. With oscilloscope (1), triggered by the 1MHz (4) frequency standard; monitor the 1MHz IN-OUT BNC for a 2.5V peak-peak (minimum amplitude) 1MHz rectangular wave. Set COARSE frequency adjustment (counter rear panel) to a position which results in most stationary waveform on scope. Set FINE frequency adjustment (optional oscillators) to position which results in most stationary waveform on scope. Place 1MHz INT-EXT switch to EXT. Oscilloscope should no longer display 1MHz signal. Remove calibration equipment.

### 5.4.3 200MHz Input Amp and Decade Adjustment (Schematic D39095)

1. Push the power switch on and depress the X1 ATTENUATOR button.
2. Apply 200MHz at a level of 10 millivolts. This is measured at the front panel as shown in Figure 5.1.
3. With the Resolution switch in 100kHz position, adjust R47 to obtain a good stable reading. Reduce the input level, and repeat the adjustment to find the optimum setting.
4. Note the input voltage level that is required for a stable reading. Increase this level by a factor of ten.
5. Depress the X10 ATTENUATOR button and adjust R50 until the 6053 just barely counts correctly. Reduce the input level and then increase it to the original X10 level. The 6053 should again present a stable correct reading. The level required should not exceed 100 millivolts.

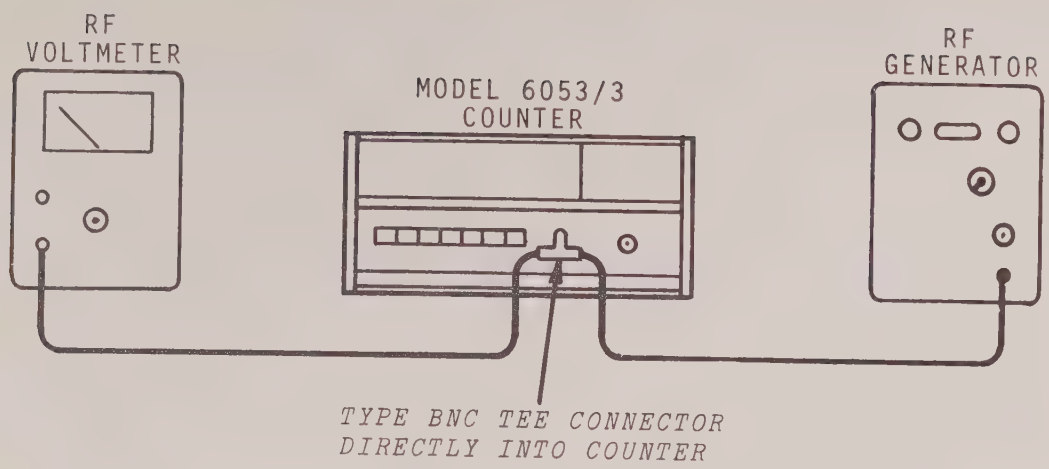



FIGURE 5.1 VOLTAGE MEASUREMENT OF RF INPUT

6. Depress the X100 ATTENUATOR button; then, increase the generator output level another factor of ten. Verify that a stable and correct indication is present. If not, repeat 5.4.3.

### 5.4.4 ACTO ADJUSTMENT

Mixer Balance

1. With no input connected to the 6053, depress the .2 - 3GHz button.
2. Observe the waveform present at TP1 on the ACTO Assy (A5). This should be a symmetrical triangular waveform swinging between +10 and -5 volts.
3. Adjust R17 on the mixer assembly (A6), if necessary, to make the waveform symmetrical.
4. Apply 3GHz to the 0.2-3GHz input at a level of -15dBm. Set R19 for a voltage of -1.75 to -2.00Vdc measured at Pin 6 of U2.

Gain Set

1. Set the resolution switch to $10^{-3}$ (1kHz) or $10^{-4}$ (10kHz) resolution.
2. Apply 3GHz at a level of 50mV rms (-13dBm) to the .2-3GHz input of the 6053.
3. Adjust the gain control R24 on the ACTO Assy (A5), so that 6053 correctly indicates the input frequency.

## 5.5 BOARD REPAIR

*NOTE*

*READ BEFORE CHANGING ANY COMPONENT ON A PRINTED-CIRCUIT BOARD*

When replacing integrated circuits or other electronic components soldered to printed-circuit boards, the procedures indicated below must be followed or damage to the board may result:

1. Determine by troubleshooting techniques, which integrated circuit or discrete component(s) has failed.
2. Remove the defective component(s) from the board by cutting the pins or leads with a small diagonal clipping tool. (Always remove and replace the entire component.)
3. Apply heat (40-50W soldering iron) sparingly to each of the cut pins or leads and remove from the board; clean the hole(s) with a toothpick or solder suction tool.
4. Form the tinned leads of the replacement part and insert in the printed circuit holes; solder, then trim leads to extend 1/16-inch beyond the back surface of the board. (Use only 63-37 solder with maximum 1/16-inch diameter.)

*CAUTION*

*Always trim semiconductor leads only after soldered installation is complete. This procedure greatly lessens the possibility of component failure due to shock-wave damage caused by the trimming tool.*

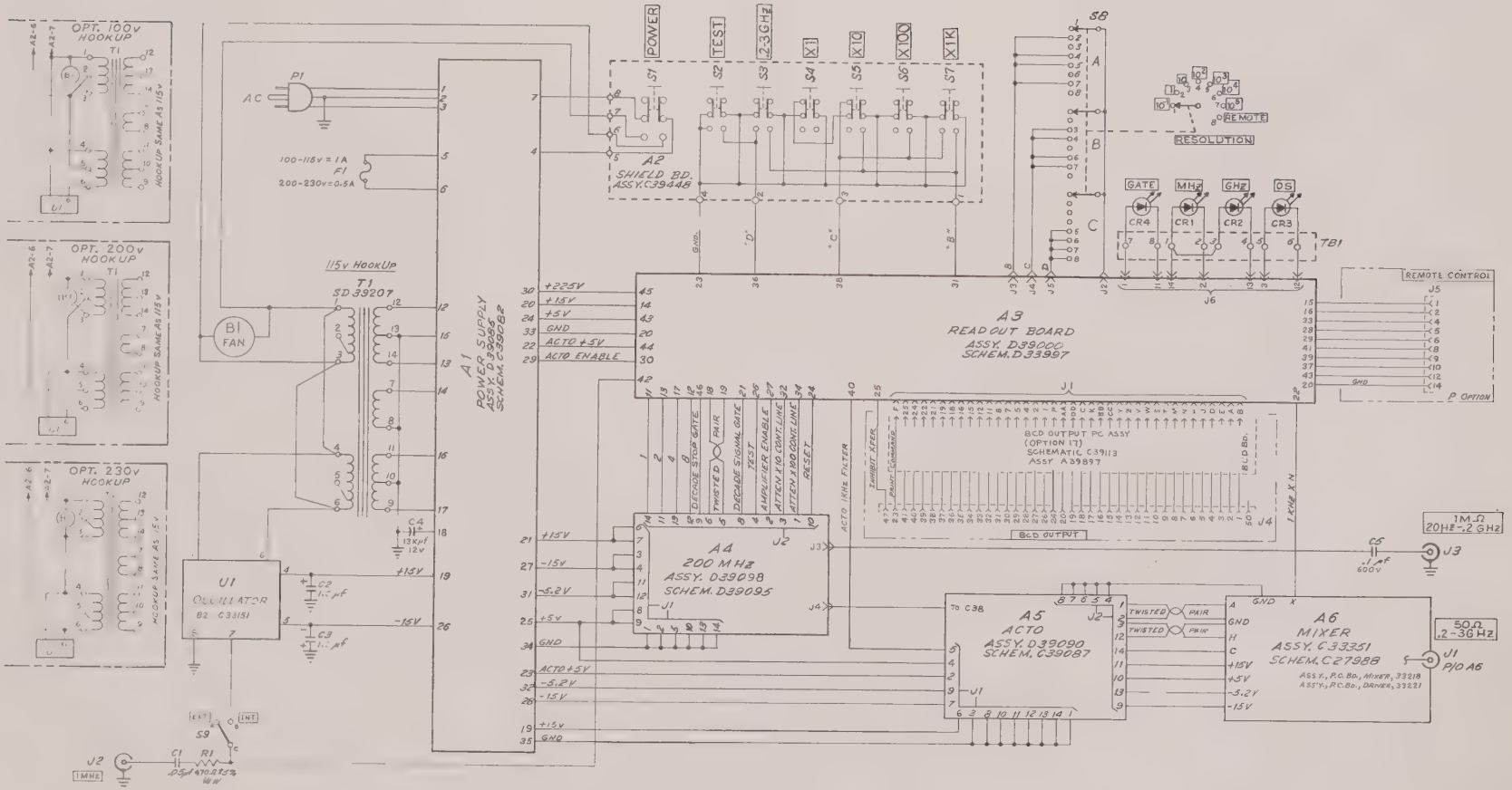
5. When soldering semiconductor devices and all small components, be sure to use a heat sink tool or long-nosed plier connected to the component lead(s) while each is being soldered. Allow the soldered connection to cool before removing the heat sink.
6. Clean all dirt and solder-flux from the printed circuit traces by liberal application of isopropyl alcohol or freon-type solvents.

# CHAPTER 6

# DRAWINGS AND PARTS LISTS

## 6.1 INTRODUCTION

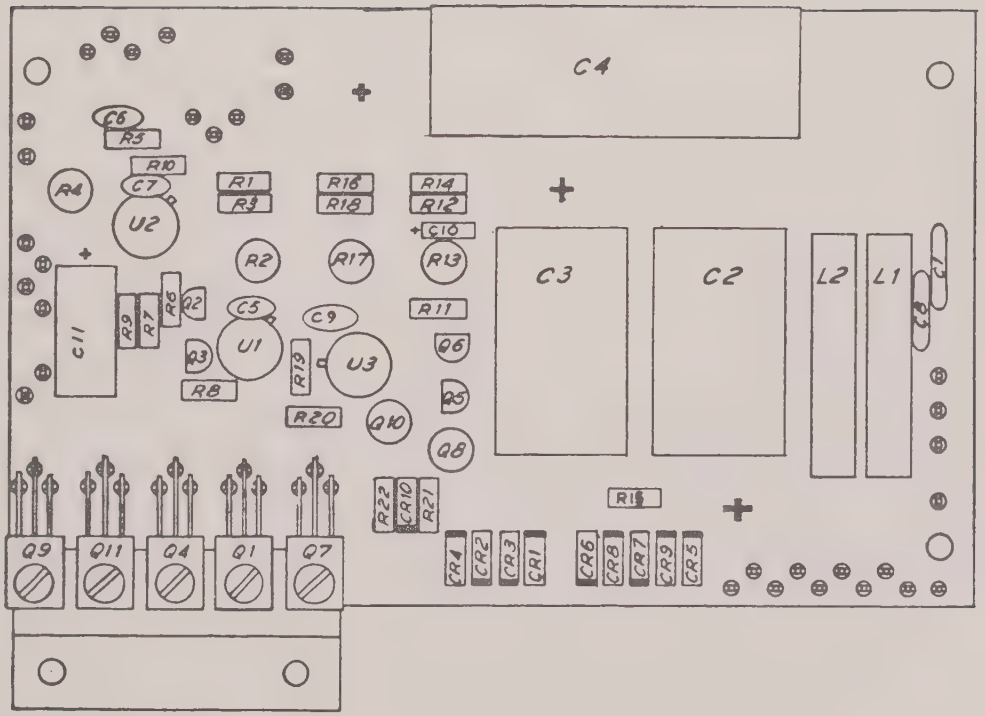
This chapter contains the drawings and parts list for the SD Model 6053 Frequency Counter. Each section is composed of an assembly, schematic, and a parts list. All sections are arranged in assembly sequence, with the exception of the Block Diagram, and the Block Diagram Parts List - these items follow immediately after this introduction.



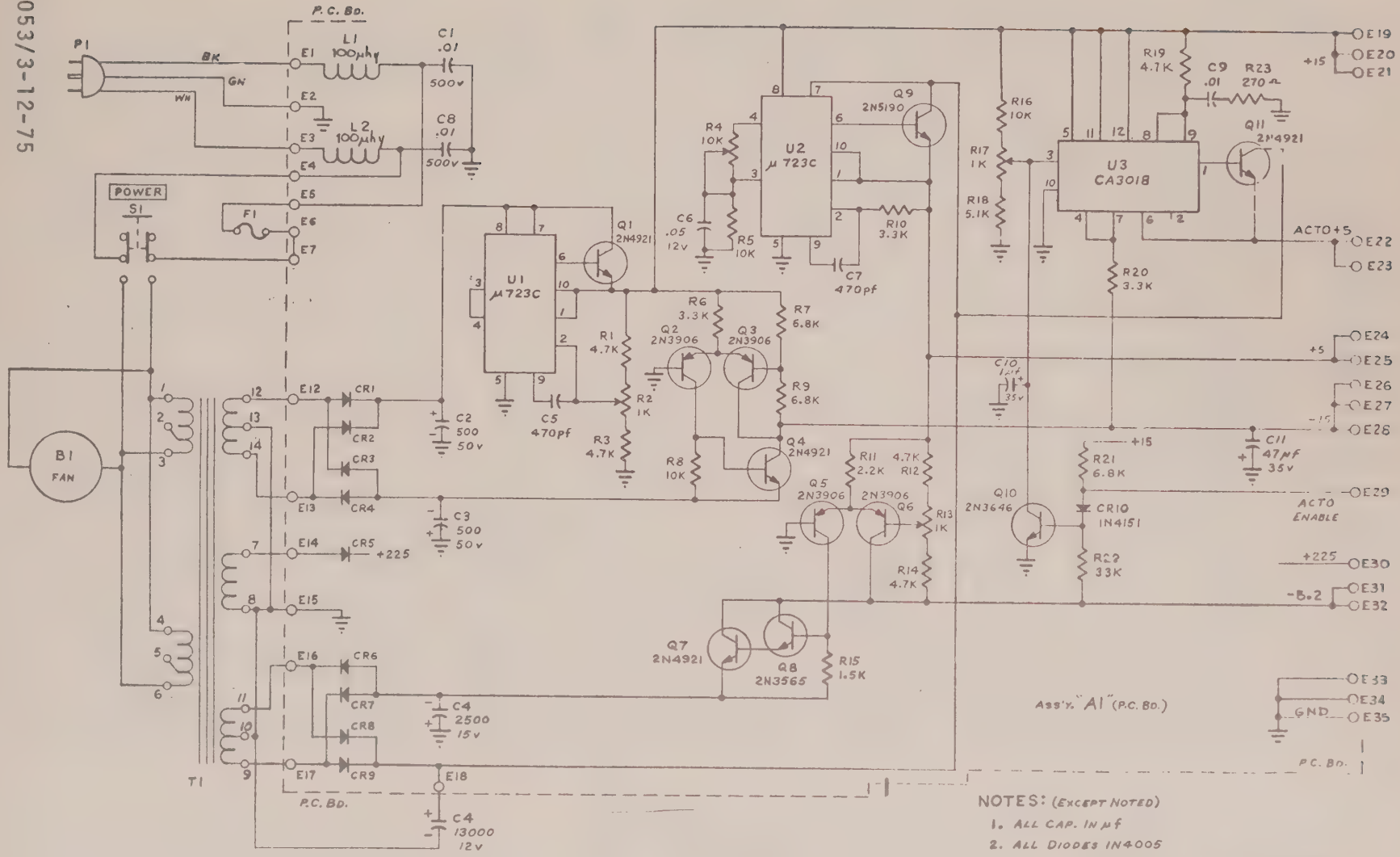

MODEL 6053/3 INTERCONNECT DIAGRAM, D39100E

# FINAL ASSEMBLY PARTS LIST

| Ref. | Description | SD Part No. |
|---|---|---|
| | Block Diagram, Model 6053/3 | D39100R3 |
| B1 | Blower | H1786 |
| C1 | Capacitor, .05 µF, 12 V | C0672 |
| C2 | Capacitor, 1.0 µF, 35 V | C0524 |
| C3 | Capacitor, 1.0 µF, 35 V | C0524 |
| C4 | Capacitor, 13 KµF, 12 V | C1122 |
| C5 | Capacitor, .1 µF, 600 V | 03285090 |
| CR1 | Assembly Lamp, Light Emitting SL1171 | CR0367 |
| CR2 | Assembly Lamp, Light Emitting SL1171 | CR0367 |
| CR3 | Assembly Lamp, Light Emitting SL1171 | CR0367 |
| CR4 | Assembly Lamp, Light Emitting SL1171 | CR0367 |
| F1 | Fuse, 1A, 3AG | F0001 |
| J1 | Connector, Female, Type N | J0552 |
| J2 | Connector, BNC | J0165 |
| J3 | Connector, BNC | J0260 |
| J4 | Connector, 50 Pin | J0170 |
| J5 | Connector, 14 Pin | J0310 |
| P1 | Line Cord | W0088 |
| R1 | Resistor, 470 Ω, 1/4W, 5% | R1044 |
| S8 | Assembly switch, Resolution | 39451 |
| S9 | Switch, Toggle, SPDT | S0149 |
| T1 | Transformer | 39207 |
| U1 | Oscillator | 33151 |
| | Filter, Polaroid | 33922 |
| | Filter, Foam | 39410 |
| | Fuse Holder | X0034 |
| | Knob | H1937 |
| | Socket, Octal | X0004 |
| | Acto Cable Assy | 39469 |
| | Acto Mixer, Cable Assy | 29475 |
| | Connector, IC | J0605 |
| | Recept. AMP 60939-1 | J0607 |




A1, POWER SUPPLY ASSEMBLY, D39085C




NOTES: (EXCEPT NOTED)

1. ALL CAP. IN μf
2. ALL DIODES IN4005
3. ALL RES. ¼W, 5%
4. F1 = 1 AMP. FAST BLO (100-115V)
   .5 " " " (200-230V)

| | LAST № | NOT USED |
|---|---|---|
| CAP. | C11 | - |
| DIODE | CR10 | - |
| INDUCT | L2 | - |
| IC | U3 | - |
| RES | R22 | - |
| TERM. | E35 | E8, 9, 10, 11 |
| XISTOR | Q11 | - |

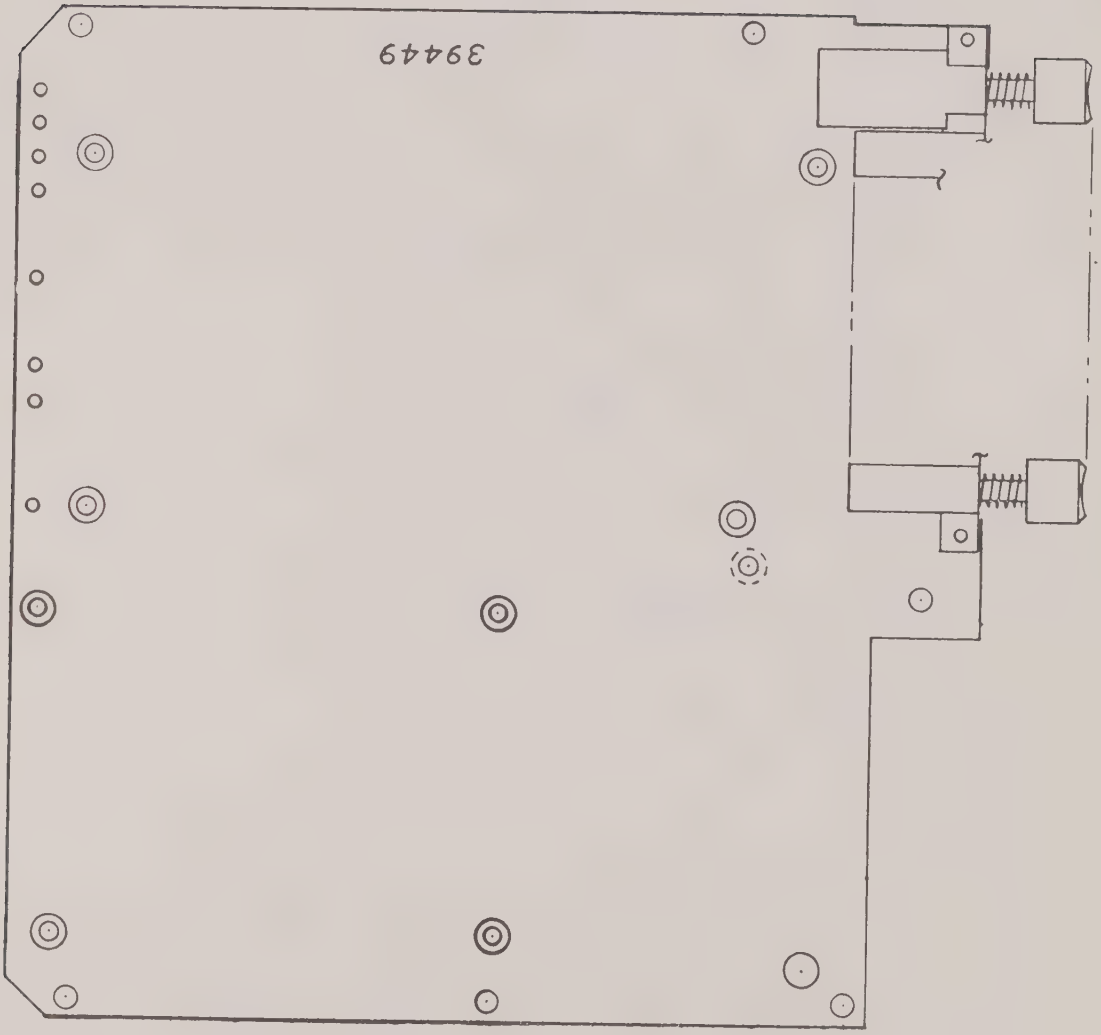
A1, POWER SUPPLY SCHEMATIC, C39082E

# A1 POWER SUPPLY PARTS LIST

| Ref. | Description | SD Part No. |
|---|---|---|
| | A1 Power Supply P.C. Assembly | D39085R2 |
| | A1 Power Supply Schematic | C39082R2 |
| C1 | Capacitor, .01 µF, 500 V | C0423 |
| C2 | Capacitor, 500 µF, 50 V | C1243 |
| C3 | Capacitor, 500 µF, 50 V | C1243 |
| C4 | Capacitor, 2500 µF, 15 V | C1148 |
| C5 | Capacitor, 470 pF, 500 V | C0542 |
| C6 | Capacitor, .05 µF, 12 V | C0672 |
| C7 | Capacitor, 470 pF, 500 V | C0542 |
| C8 | Capacitor, .01 µF, 500 V | C0423 |
| C9 | Capacitor, 470 pF, 500 V | C0542 |
| CR1 | Diode, 1N4005 | CR0284 |
| CR2 | Diode, 1N4005 | CR0284 |
| CR3 | Diode, 1N4005 | CR0284 |
| CR4 | Diode, 1N4005 | CR0284 |
| CR5 | Diode, 1N4005 | CR0284 |
| CR6 | Diode, 1N4005 | CR0284 |
| CR7 | Diode, 1N4005 | CR0284 |
| CR8 | Diode, 1N4005 | CR0284 |
| CR9 | Diode, 1N4005 | CR0284 |
| CR10 | Diode, 1N4151 | CR0150 |
| L1 | Inductor, 100 µH, ±20% | L0166 |
| L2 | Inductor, 100 µH, ±20% | L0166 |
| Q1 | Transistor, 2N4921 | Q0267 |
| Q2 | Transistor, 2N3906 | Q0248 |
| Q3 | Transistor, 2N3906 | Q0248 |
| Q4 | Transistor, 2N4921 | Q0267 |
| Q5 | Transistor, 2N3906 | Q0248 |
| Q6 | Transistor, 2N3906 | Q0248 |
| Q7 | Transistor, 2N4921 | Q0267 |
| Q8 | Transistor, 2N3565 | Q0237 |
| Q9 | Transistor, 2N5190 | Q0281 |
| Q10 | Transistor, 2N3646 | Q0218 |
| Q11 | Transistor, 2N4921 | Q0267 |
| R1 | Resistor, 4.7 k, 1/4 W, 5% | R0892 |
| R2 | Resistor, VAR., 1 k | R2390 |
| R3 | Resistor, 4.7 k, 1/4W, 5% | R0892 |
| R4 | Resistor, VAR., 10 k | R2383 |
| R5 | Resistor, 10 k, 1/4 W, 5% | R0766 |

## A1 POWER SUPPLY PARTS LIST (Cont'd)

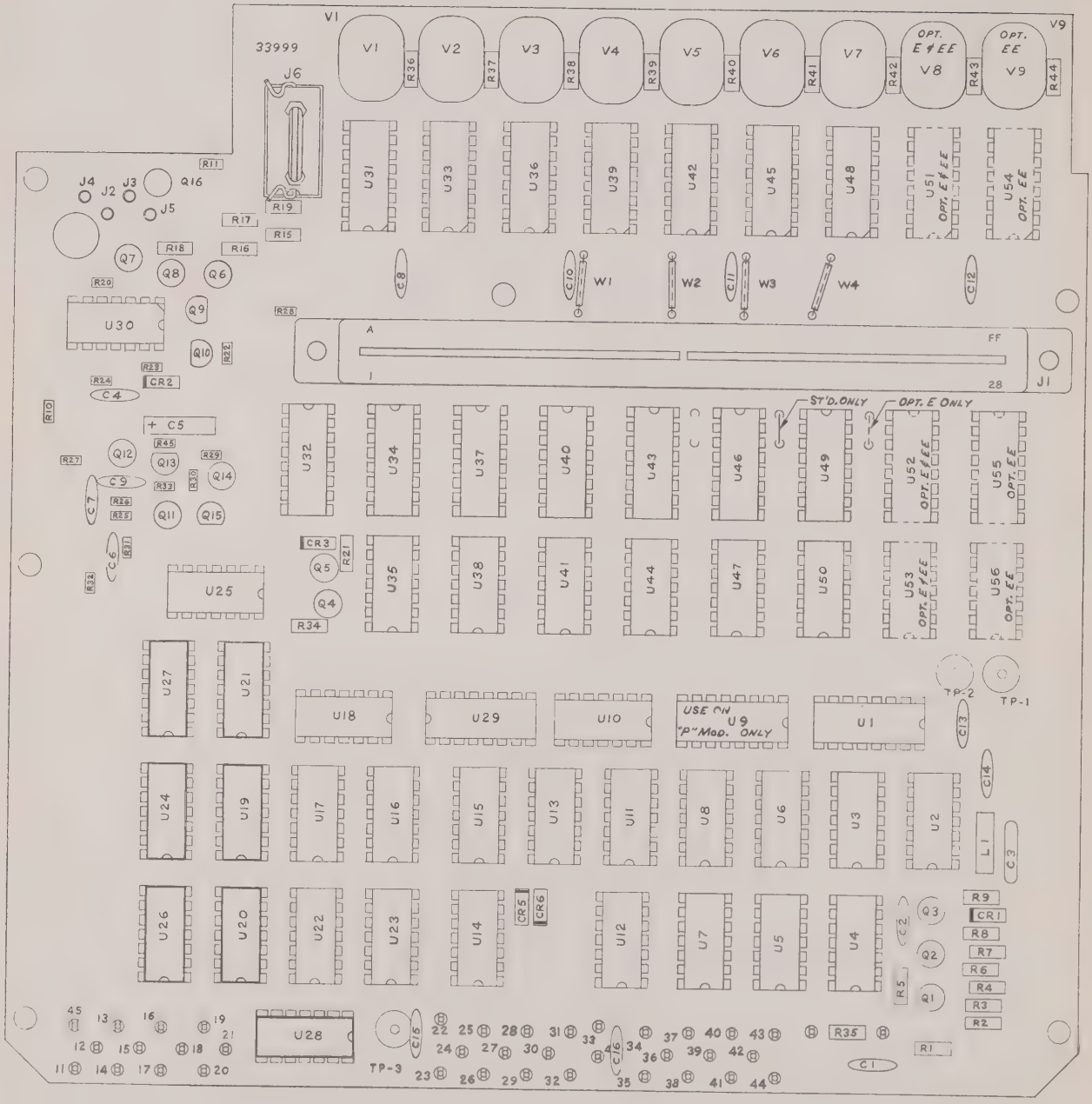
| Ref. | Description | SD Part No. |
|---|---|---|
| R6 | Resistor, 3.3 k, 1/4 W, 5% | R0742 |
| R7 | Resistor, 6.8 k, 1/4 W, 5% | R0696 |
| R8 | Resistor, 10 k, 1/4 W, 5% | R0766 |
| R9 | Resistor, 6.8 k, 1/4 W, 5% | R0696 |
| R10 | Resistor, 3.3 k, 1/4 W, 5% | R0742 |
| R11 | Resistor, 2.2 k, 1/4 W, 5% | R0794 |
| R12 | Resistor, 4.7 k, 1/4 W, 5% | R0892 |
| R13 | Resistor, VAR., 1 k | R2390 |
| R14 | Resistor, 4.7 k, 1/4 W, 5% | R0892 |
| R15 | Resistor, 1.5 k, 1/4 W, 5% | R0783 |
| R16 | Resistor, 10 k, 1/4 W, 5% | R0766 |
| R17 | Resistor, VAR., 1 k | R2390 |
| R18 | Resistor, 5.1 k, 1/4 W, 5% | R0693 |
| R19 | Resistor, 4.7 k, 1/4 W, 5% | R0892 |
| R20 | Resistor, 3.3 k, 1/4 W, 5% | R0742 |
| R21 | Resistor, 6.8 k, 1/4 W, 5% | R0696 |
| R22 | Resistor, 33 k, 1/4 W, 5% | R0780 |
| U1 | Integrated Circuit, µ723C | 25756 |
| U2 | Integrated Circuit, µ723C | 25756 |
| U3 | Integrated Circuit, CA3018 | 25720 |
| C10 | Capacitor, 1 µF, 35 V | C0524 |
| C11 | Capacitor, 47 µF, 35 V | C0982 |



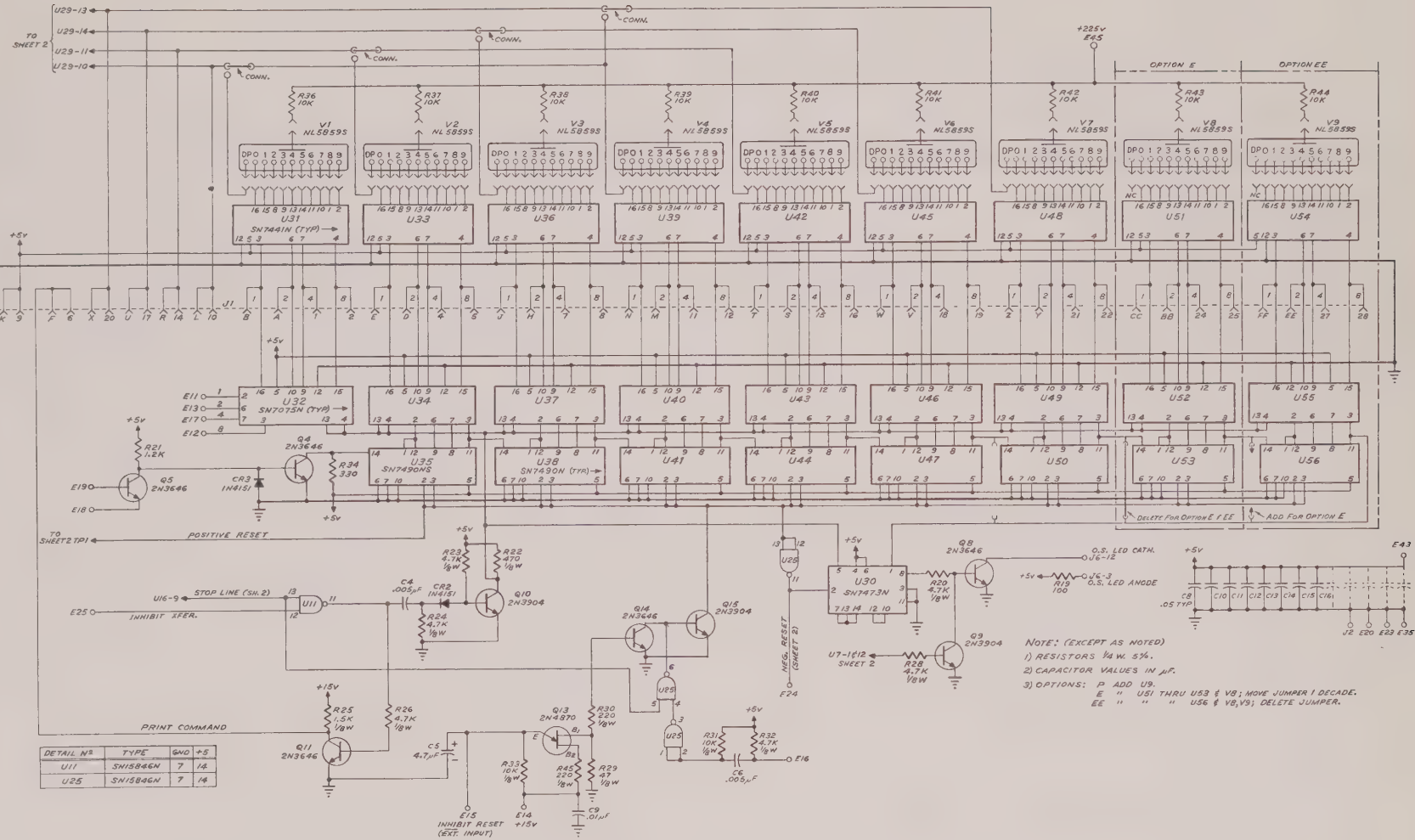

A2, SHIELD BOARD ASSEMBLY, C39448R2

# A2 SHIELD PARTS LIST

| REF. | DESCRIPTION | SD PART NO. |
|---|---|---|
| | A2 Shield P.C. Assembly | C39448R2 |
| | A2 Shield Schematic | P/O D39100R3 |
| S1 | Switch, Pushbutton, 7 STA W/Buttons | S0392 |
| S2 | Switch, Pushbutton, 7 STA W/Buttons | S0392 |
| S3 | Switch, Pushbutton, 7 STA W/Buttons | S0392 |
| S4 | Switch, Pushbutton, 7 STA W/Buttons | S0392 |
| S5 | Switch, Pushbutton, 7 STA W/Buttons | S0392 |
| S6 | Switch, Pushbutton, 7 STA W/Buttons | S0392 |
| S7 | Switch, Pushbutton, 7 STA W/Buttons | S0392 |

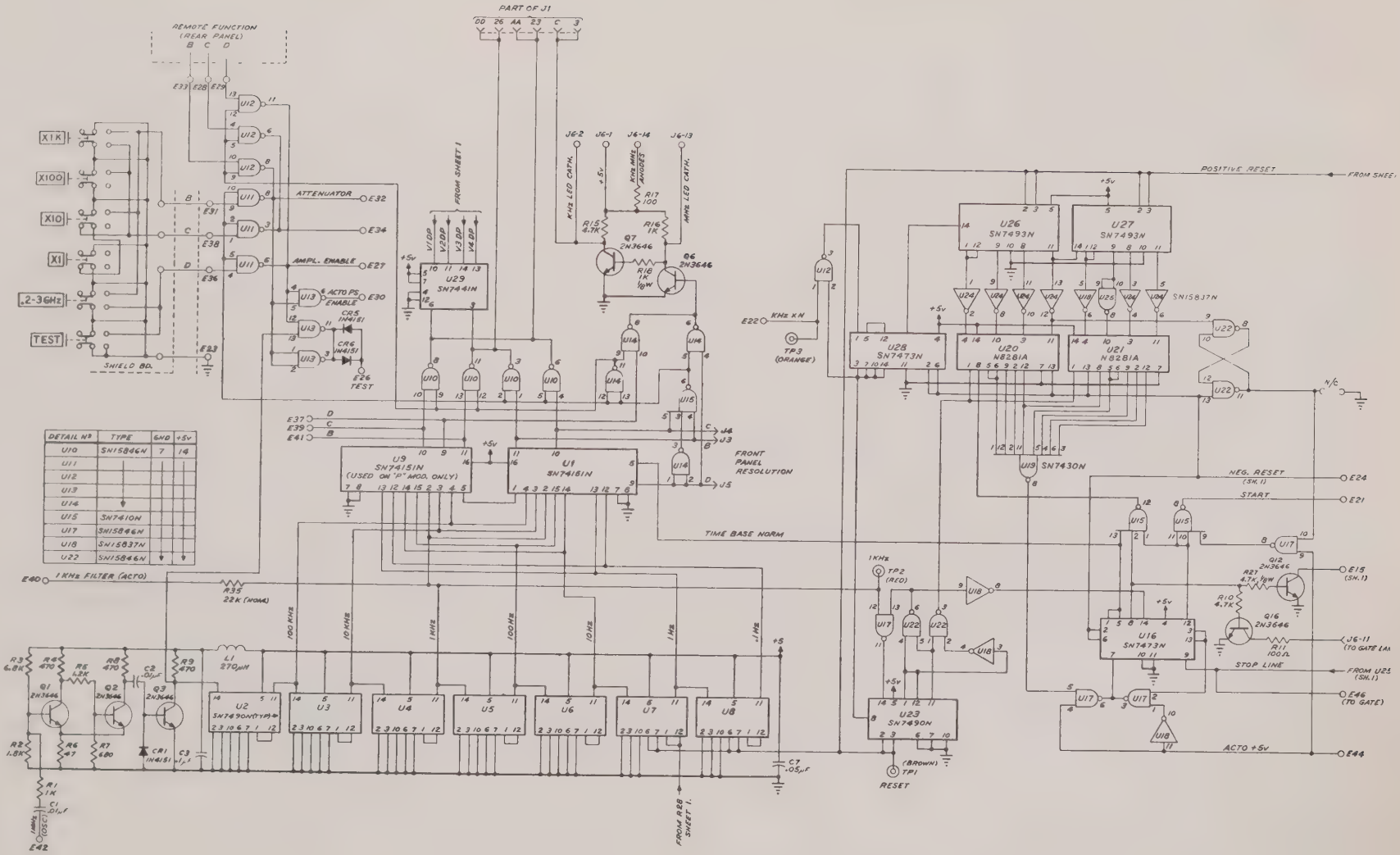



A3, READOUT P.C. ASSEMBLY, D39000C




| DETAIL Nº | TYPE | GND | +5 |
|---|---|---|---|
| U11 | SN1584GN | 7 | 14 |
| U25 | SN1584GN | 7 | 14 |

A3, READOUT SCHEMATIC, SHEET 1 OF 2, D33997B




| DETAIL Nº | TYPE | GND | +5V |
|---|---|---|---|
| U10 | SN15846N | 7 | 14 |
| U11 | | | |
| U12 | | | |
| U13 | | | |
| U14 | | | |
| U15 | SN7410N | | |
| U17 | SN15846N | | |
| U18 | SN15837N | | |
| U22 | SN15846N | | |

A3, READOUT SCHEMATIC, SHEET 2 OF 2, D33997B

# A3 READOUT BOARD PARTS LIST

| Ref. | Description | SD Part No. |
|---|---|---|
| | A3 Readout Board P.C. Assembly | D39000R2 |
| | A3 Readout Board Schematic | D33997R4 |
| C1 | Capacitor, .01 µF, 100 V | C0556 |
| C2 | Capacitor, .01 µF, 100 V | C0556 |
| C3 | Capacitor, .1 µF, 50 V | C0881 |
| C4 | Capacitor, .005 µF, 150 V | C0325 |
| C5 | Capacitor, 4.7 µF, 35 V | C0406 |
| C6 | Capacitor, .005 µF, 150 V | C0325 |
| C7 | Capacitor, .05 µF, 12 V | C0672 |
| C8 | Capacitor, .05 µF, 12 V | C0672 |
| C9 | Capacitor, .01 µF, 100 V | C0556 |
| C10 | Capacitor, .05 µF, 12 V | C0672 |
| C11 | Capacitor, .05 µF, 12 V | C0672 |
| C12 | Capacitor, .05 µF, 12 V | C0672 |
| C13 | Capacitor, .05 µF, 12 V | C0672 |
| C14 | Capacitor, .05 µF, 12 V | C0672 |
| C15 | Capacitor, .05 µF, 12 V | C0672 |
| C16 | Capacitor, .05 µF, 12 V | C0672 |
| CR1 | Diode, 1N4151 | CR0150 |
| CR2 | Diode, 1N4151 | CR0150 |
| CR3 | Diode, 1N4151 | CR0150 |
| CR4 | Not Used | |
| CR5 | Diode, 1N4151 | CR0150 |
| CR6 | Diode, 1N4151 | CR0150 |
| J1 | Connector, P.C., 28/56, 2VH28/1AV5 | 09060800 |
| J2 | Connector, Post, AMP 61067-1 | E0318 |
| J3 | Connector, Post, AMP 61067-1 | E0318 |
| J4 | Connector, Post, AMP 61067-1 | E0318 |
| J5 | Connector, Post, AMP 61067-1 | E0318 |
| J6 | Connector, Socket, I.C. 14 Term | X0186 |
| L1 | Inductor, 270 µH | L0067 |
| Q1 | Transistor, 2N3646 | Q0218 |
| Q2 | Transistor, 2N3646 | Q0218 |
| Q3 | Transistor, 2N3646 | Q0218 |
| Q4 | Transistor, 2N3646 | Q0218 |
| Q5 | Transistor, 2N3646 | Q0218 |
| Q6 | Transistor, 2N3646 | Q0218 |
| Q7 | Transistor, 2N3646 | Q0218 |

## A3 READOUT BOARD PARTS LIST (Cont'd)

| Ref. | Description | SD Part No. |
|---|---|---|
| Q8 | Transistor, 2N3646 | Q0218 |
| Q9 | Transistor, 2N3904 | Q0247 |
| Q10 | Transistor, 2N3904 | Q0247 |
| Q11 | Transistor, 2N3646 | Q0218 |
| Q12 | Transistor, 2N3646 | Q0218 |
| Q13 | Transistor, 2N4870 | Q0266 |
| Q14 | Transistor, 2N3646 | Q0218 |
| Q15 | Transistor, 2N3904 | Q0247 |
| Q16 | Transistor, 2N3646 | Q0218 |
| R1 | Resistor, 1 k, 1/4 W, 5% | R0765 |
| R2 | Resistor, 1.8 k, 1/4 W, 5% | R0959 |
| R3 | Resistor, 6.8 k, 1/4 W, 5% | R0696 |
| R4 | Resistor, 470 Ω, 1/4 W, 5% | R1044 |
| R5 | Resistor, 1.2 k, 1/4 W, 5% | R0809 |
| R6 | Resistor, 47 Ω, 1/4 W, 5% | R0743 |
| R7 | Resistor, 680 Ω, 1/4 W, 5% | R1234 |
| R8 | Resistor, 470 Ω, 1/4 W, 5% | R1044 |
| R9 | Resistor, 470 Ω, 1/4 W, 5% | R1044 |
| R10 | Resistor, 4.7 k, 1/8 W, 5% | R1733 |
| R11 | Resistor, 100 Ω, 1/4 W | R0966 |
| R12 | Not Used | |
| R13 | Not Used | |
| R14 | Not Used | |
| R15 | Resistor, 4.7 k, 1/4 W, 5% | R0892 |
| R16 | Resistor, 1 k, 1/4 W, 5% | R0765 |
| R17 | Resistor, 100 Ω, 1/4 W, 5% | R0966 |
| R18 | Resistor, 1 k, 1/4 W, 5% | R0765 |
| R19 | Resistor, 100 Ω, 1/4 W, 5% | R0966 |
| R20 | Resistor, 4.7 k, 1/8 W, 5% | R1733 |
| R21 | Resistor, 1.2 k, 1/4 W, 5% | R0809 |
| R22 | Resistor, 470 Ω, 1/8 W, 5% | R1451 |
| R23 | Resistor, 4.7 k, 1/8 W, 5% | R1733 |
| R24 | Resistor, 4.7 k, 1/8 W, 5% | R1733 |
| R25 | Resistor, 1.5 k, 1/8 W, 5% | R2463 |
| R26 | Resistor, 4.7 k, 1/8 W, 5% | R1733 |
| R27 | Resistor, 4.7 k, 1/8 W, 5% | R1733 |
| R28 | Resistor, 4.7 k, 1/8 W, 5% | R1733 |
| R29 | Resistor, 47 Ω, 1/8 W, 5% | R1449 |
| R30 | Resistor, 220 Ω, 1/8 W, 5% | R1743 |
| R31 | Resistor, 10 k, 1/8 W, 5% | R1437 |
| R32 | Resistor, 4.7 k, 1/8 W, 5% | R1733 |

## A3 READOUT BOARD PARTS LIST (Cont'd)

| Ref. | Description | SD Part No. |
|---|---|---|
| R33 | Resistor, 10 k, 1/8 W, 5% | R1437 |
| R34 | Resistor, 330 Ω, 1/4 W, 5% | R0662 |
| R35 | Resistor, 22 k, 1/4 W, 5% | R0768 |
| R36 | Resistor, 10 k, 1/4 W, 5% | R0766 |
| R37 | Resistor, 10 k, 1/4 W, 5% | R0766 |
| R38 | Resistor, 10 k, 1/4 W, 5% | R0766 |
| R39 | Resistor, 10 k, 1/4 W, 5% | R0766 |
| R40 | Resistor, 10 k, 1/4 W, 5% | R0766 |
| R41 | Resistor, 10 k, 1/4 W, 5% | R0766 |
| R42 | Resistor, 10 k, 1/4 W, 5% | R0766 |
| R43 | Resistor, 10 k, 1/4 W, 5% | R0766 |
| R44 | Resistor, 10 k, 1/4 W, 5% | R0766 |
| R45 | Resistor, 220 Ω, 1/8 W, 5% | R1743 |
| TP1 | Test Point, Brown | E0284 |
| TP2 | Test Point, Red | E0279 |
| TP3 | Test Point, Orange | E0282 |
| U1 | Integrated Circuit, SN74151N | 25771 |
| U2 | Integrated Circuit, SN7090N | 25732 |
| U3 | Integrated Circuit, SN7090N | 25732 |
| U4 | Integrated Circuit, SN7090N | 25732 |
| U5 | Integrated Circuit, SN7090N | 25732 |
| U6 | Integrated Circuit, SN7090N | 25732 |
| U7 | Integrated Circuit, SN7090N | 25732 |
| U8 | Integrated Circuit, SN7090N | 25732 |
| U9 | Not Used | |
| U10 | Integrated Circuit, SN15846 | 19716 |
| U11 | Integrated Circuit, SN15846 | 19716 |
| U12 | Integrated Circuit, SN15846 | 19716 |
| U13 | Integrated Circuit, SN15846 | 19716 |
| U14 | Integrated Circuit, SN15846 | 19716 |
| U15 | Integrated Circuit, SN7410N | 19706 |
| U16 | Integrated Circuit, SN7473N | 19709 |
| U17 | Integrated Circuit, SN15846 | 19716 |
| U18 | Integrated Circuit, SN15837N | 25728 |
| U19 | Integrated Circuit, SN7430N | 25726 |
| U20 | Integrated Circuit, SN8281A | 25727 |
| U21 | Integrated Circuit, SN8281A | 25727 |
| U22 | Integrated Circuit, SN15846 | 19716 |
| U23 | Integrated Circuit, SN7090N | 25732 |
| U24 | Integrated Circuit, SN15837N | 25728 |

## A3 READOUT BOARD PARTS LIST (Cont'd)

| Ref. | Description | SD Part No. |
|---|---|---|
| U25 | Integrated Circuit, SN15846 | 19716 |
| U26 | Integrated Circuit, SN7493N | 25715 |
| U27 | Integrated Circuit, SN7493N | 25715 |
| U28 | Integrated Circuit, SN7473N | 19709 |
| U29 | Integrated Circuit, SN7441N | 19707 |
| U30 | Integrated Circuit, SN7473N | 19709 |
| U31 | Integrated Circuit, SN7441N | 19707 |
| U32 | Integrated Circuit, SN7075N | 25731 |
| U33 | Integrated Circuit, SN7441N | 19707 |
| U34 | Integrated Circuit, SN7075N | 25731 |
| U35 | Integrated Circuit, SN7490N | 19711 |
| U36 | Integrated Circuit, SN7441N | 19707 |
| U37 | Integrated Circuit, SN7075N | 25731 |
| U38 | Integrated Circuit, SN7090N | 25732 |
| U39 | Integrated Circuit, SN7441N | 19707 |
| U40 | Integrated Circuit, SN7075N | 25731 |
| U41 | Integrated Circuit, SN7090N | 25732 |
| U42 | Integrated Circuit, SN7441N | 19707 |
| U43 | Integrated Circuit, SN7075N | 25731 |
| U44 | Integrated Circuit, SN7090N | 25732 |
| U45 | Integrated Circuit, SN7441N | 19707 |
| U46 | Integrated Circuit, SN7075N | 25731 |
| U47 | Integrated Circuit, SN7090N | 25732 |
| U48 | Integrated Circuit, SN7441N | 19707 |
| U49 | Integrated Circuit, SN7075N | 25731 |
| U50 | Integrated Circuit, SN7090N | 25732 |
| V1 | Tube, Readout, NL5859S | V0131 |
| V2 | Tube, Readout, NL5859S | V0131 |
| V3 | Tube, Readout, NL5859S | V0131 |
| V4 | Tube, Readout, NL5859S | V0131 |
| V5 | Tube, Readout, NL5859S | V0131 |
| V6 | Tube, Readout, NL5859S | V0131 |
| V7 | Tube, Readout, NL5859S | V0131 |
| XU1 | Integrated Circuit Socket, 8 Term | X0185 |
| XU2 | Integrated Circuit Socket, 7 Term | X0184 |
| XU3 | Integrated Circuit Socket, 7 Term | X0184 |
| XU4 | Integrated Circuit Socket, 7 Term | X0184 |
| XU5 | Integrated Circuit Socket, 7 Term | X0184 |
| XU6 | Integrated Circuit Socket, 7 Term | X0184 |
| XU7 | Integrated Circuit Socket, 7 Term | X0184 |

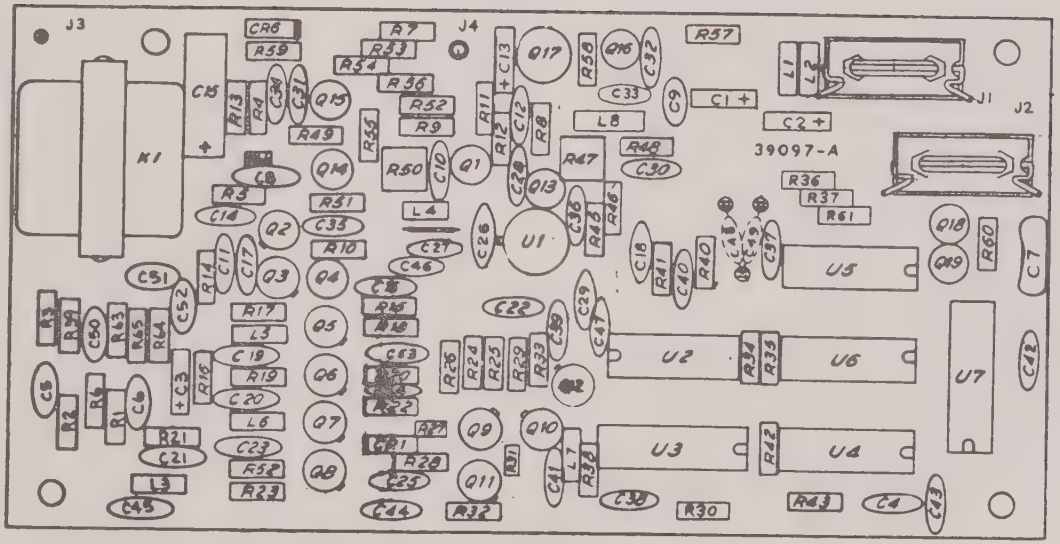
## A3 READOUT BOARD PARTS LIST (Cont'd)

| Ref. | Description | SD Part No. |
|---|---|---|
| XU8 | Integrated Circuit Socket, 7 Term | X0184 |
| XU9 | Integrated Circuit Socket, 8 Term | X0185 |
| XU10 | Integrated Circuit Socket, 7 Term | X0184 |
| XU11 | Integrated Circuit Socket, 7 Term | X0184 |
| XU12 | Integrated Circuit Socket, 7 Term | X0184 |
| XU13 | Integrated Circuit Socket, 7 Term | X0184 |
| XU14 | Integrated Circuit Socket, 7 Term | X0184 |
| XU15 | Integrated Circuit Socket, 7 Term | X0184 |
| XU16 | Integrated Circuit Socket, 7 Term | X0184 |
| XU17 | Integrated Circuit Socket, 7 Term | X0184 |
| XU18 | Integrated Circuit Socket, 7 Term | X0184 |
| XU19 | Integrated Circuit Socket, 7 Term | X0184 |
| XU20 | Integrated Circuit Socket, 7 Term | X0184 |
| XU21 | Integrated Circuit Socket, 7 Term | X0184 |
| XU22 | Integrated Circuit Socket, 7 Term | X0184 |
| XU23 | Integrated Circuit Socket, 7 Term | X0184 |
| XU24 | Integrated Circuit Socket, 7 Term | X0184 |
| XU25 | Integrated Circuit Socket, 7 Term | X0184 |
| XU26 | Integrated Circuit Socket, 7 Term | X0184 |
| XU27 | Integrated Circuit Socket, 7 Term | X0184 |
| XU28 | Integrated Circuit Socket, 7 Term | X0184 |
| XU29 | Integrated Circuit Socket, 8 Term | X0185 |
| XU30 | Integrated Circuit Socket, 7 Term | X0184 |
| XU31 | Integrated Circuit Socket, 8 Term | X0185 |
| XU32 | Integrated Circuit Socket, 8 Term | X0185 |
| XU33 | Integrated Circuit Socket, 8 Term | X0185 |
| XU34 | Integrated Circuit Socket, 8 Term | X0185 |
| XU35 | Integrated Circuit Socket, 7 Term | X0184 |
| XU36 | Integrated Circuit Socket, 8 Term | X0185 |
| XU37 | Integrated Circuit Socket, 8 Term | X0185 |
| XU38 | Integrated Circuit Socket, 7 Term | X0184 |
| XU39 | Integrated Circuit Socket, 8 Term | X0185 |
| XU40 | Integrated Circuit Socket, 8 Term | X0185 |
| XU41 | Integrated Circuit Socket, 7 Term | X0184 |
| XU42 | Integrated Circuit Socket, 8 Term | X0185 |
| XU43 | Integrated Circuit Socket, 8 Term | X0185 |
| XU44 | Integrated Circuit Socket, 7 Term | X0184 |
| XU45 | Integrated Circuit Socket, 8 Term | X0185 |
| XU46 | Integrated Circuit Socket, 8 Term | X0185 |
| XU47 | Integrated Circuit Socket, 7 Term | X0184 |
| XU48 | Integrated Circuit Socket, 8 Term | X0185 |

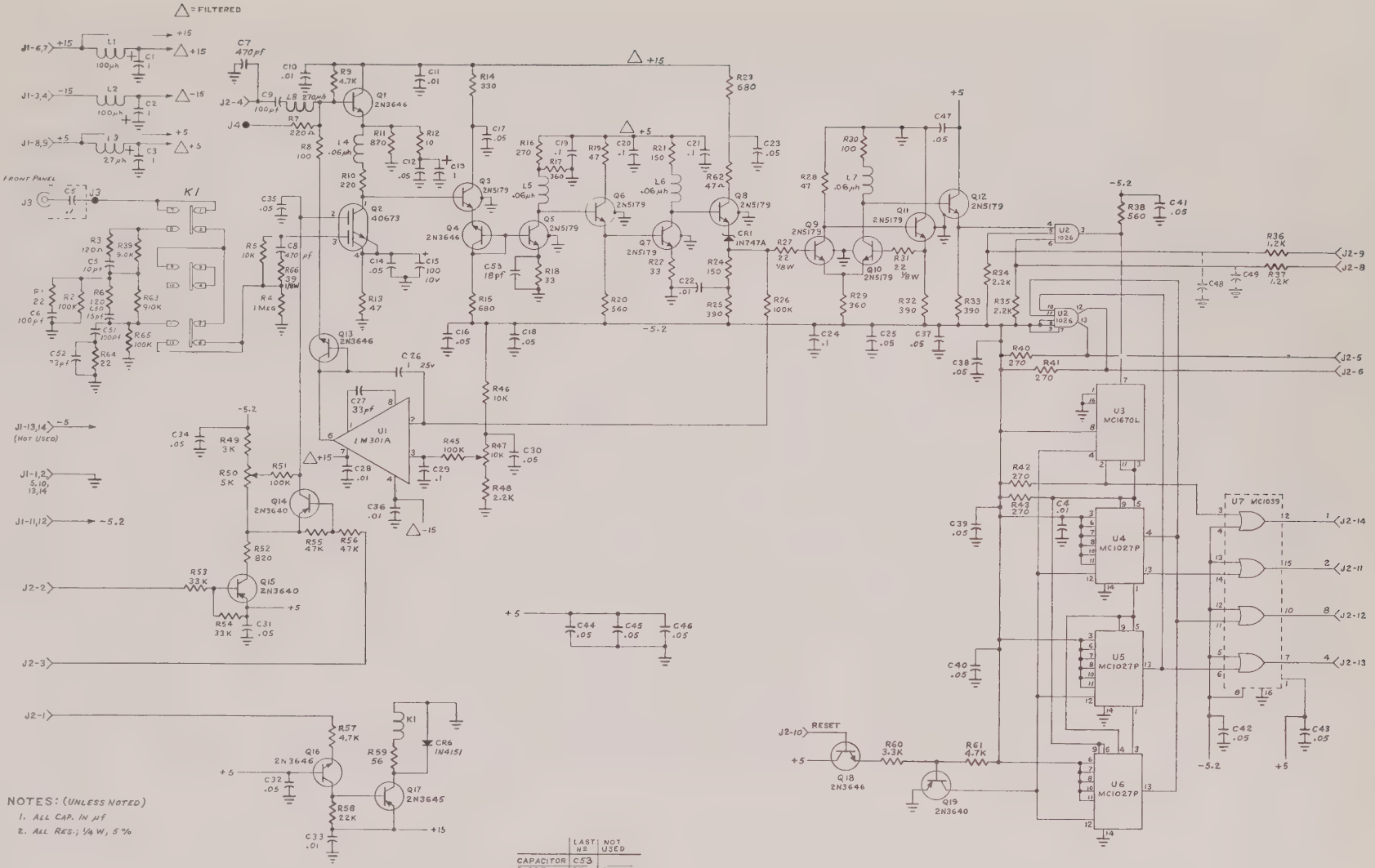
## A3 READOUT BOARD PARTS LIST (Cont'd)

| Ref. | Description | SD Part No. |
|---|---|---|
| XU49 | Integrated Circuit Socket, 8 Term | X0185 |
| XU50 | Integrated Circuit Socket, 7 Term | X0184 |
| XU51 | Integrated Circuit Socket, 8 Term | X0185 |
| XU52 | Integrated Circuit Socket, 8 Term | X0185 |
| XU53 | Integrated Circuit Socket, 7 Term | X0184 |
| XU54 | Integrated Circuit Socket, 8 Term | X0185 |
| XU55 | Integrated Circuit Socket, 8 Term | X0185 |
| XU56 | Integrated Circuit Socket, 7 Term | X0184 |
| XV1 | Socket, Tube, RTS-44 | X0179 |
| XV2 | Socket, Tube, RTS-44 | X0179 |
| XV3 | Socket, Tube, RTS-44 | X0179 |
| XV4 | Socket, Tube, RTS-44 | X0179 |
| XV5 | Socket, Tube, RTS-44 | X0179 |
| XV6 | Socket, Tube, RTS-44 | X0179 |
| XV7 | Socket, Tube, RTS-44 | X0179 |
| XV8 | Socket, Tube, RTS-44 | X0179 |
| XV9 | Socket, Tube, RTS-44 | X0179 |
| V4W1 | Jumper, DP | |
| V5W2 | Jumper, DP | |
| V6W3 | Jumper, DP | |
| V7W4 | Jumper, DP | |

NOTES




A4, 200MHz AMP & DECADE ASSEMBLY, D39098F




| | LAST M# | NOT USED |
|---|---|---|
| CAPACITOR | C53 | |
| DIODE | CR6 | 2, 3, 4, 5 |
| I C | U7 | - |
| INDUCTOR | L8 | - |
| RELAY | K1 | - |
| RESISTOR | R66 | |
| TRANSISTOR | Q19 | - |
| CONNECTOR | J4 | - |

A4, 200MHz AMP & DECADE SCHEMATIC, D39095E

# A4 200MHz AMP & DECADE PARTS LIST

| Ref. | Description | SD Part No. |
|---|---|---|
| | 200MHz Amp & Decade P.C. Assembly | D39098R5 |
| | 200MHz Amp & Decade Schematic | D39095R4 |
| C1 | Capacitor, 1 µF, 35 V, Tant | C0524 |
| C2 | Capacitor, 1 µF, 35 V, Tant | C0524 |
| C3 | Capacitor, 1 µF, 35 V, Tant | C0524 |
| C4 | Capacitor, .01 µF, 100 V, Disc | C0556 |
| C5 | Capacitor, 10 pF, 500 V, DM10 | C1193 |
| C6 | Capacitor, 100 pF, 500 V, DM10 | C1156 |
| C7 | Capacitor, 470 pF, 300 V, DM15 | C0542 |
| C8 | Capacitor, 470 pF, 300 V, DM15 | C0542 |
| C9 | Capacitor, 100 pF, 500 V, DM10 | C1156 |
| C10 | Capacitor, .01 µF, 100 V, Disc | C0556 |
| C11 | Capacitor, .01 µF, 100 V, Disc | C0556 |
| C12 | Capacitor, .05 µF, 12 V | C0672 |
| C13 | Capacitor, 1 µF, 35 V, Tant | C0524 |
| C14 | Capacitor, .05 µF, 12 V | C0672 |
| C15 | Capacitor, 100 µF, 10 V, Disc | C0660 |
| C16 | Capacitor, .05 µF, 12 V | C0672 |
| C17 | Capacitor, .05 µF, 12 V | C0672 |
| C18 | Capacitor, .05 µF, 12 V | C0672 |
| C19 | Capacitor, .1 µF, 10 V, Disc | C0661 |
| C20 | Capacitor, .1 µF, 10 V, Disc | C0661 |
| C21 | Capacitor, .1 µF, 10 V, Disc | C0661 |
| C22 | Capacitor, .01 µF, 100 V, Disc | C0556 |
| C23 | Capacitor, .05 µF, 12 V | C0672 |
| C24 | Capacitor, .1 µF, 10 V, Disc | C0661 |
| C25 | Capacitor, .05 µF, 12 V | C0672 |
| C26 | Capacitor, 1 µF, 25 V, Cerm | C0879 |
| C27 | Capacitor, 33 pF, 500 V, DM15 | C0531 |
| C28 | Capacitor, .01 µF, 100 V Disc | C0556 |
| C29 | Capacitor, 1 µF, 10 V, Disc | C0661 |
| C30 | Capacitor, .05 µF, 12 V | C0672 |
| C31 | Capacitor, .05 µF, 12 V | C0672 |
| C32 | Capacitor, .05 µF, 12 V | C0672 |
| C33 | Capacitor, .01 µF, 100 V, Disc | C0556 |
| C34 | Capacitor, .05 µF, 12 V | C0672 |
| C35 | Capacitor, .05 µF, 12 V | C0672 |
| C36 | Capacitor, .01 µF, 100 V, Disc | C0556 |
| C37 | Capacitor, .05 µF, 12 V | C0672 |
| C38 | Capacitor, .05 µF, 12 V | C0672 |

## A4 200MHz AMP & DECADE PARTS LIST (Cont'd)

| Ref. | Description | SD Part No. |
|---|---|---|
| C39 | Capacitor, .05 µF, 12 V | C0672 |
| C40 | Capacitor, .05 µF, 12 V | C0672 |
| C41 | Capacitor, .05 µF, 12 V | C0672 |
| C42 | Capacitor, .05 µF, 12 V | C0672 |
| C43 | Capacitor, .05 µF, 12 V | C0672 |
| C44 | Capacitor, .05 µF, 12 V | C0672 |
| C45 | Capacitor, .05 µF, 12 V | C0672 |
| C46 | Capacitor, .05 µF, 12 V | C0672 |
| C47 | Capacitor, .05 µF, 12 V | C0672 |
| C48 | Capacitor, Selected | Cxxxx |
| C49 | Capacitor, Selected | Cxxxx |
| C50 | Capacitor, 15 pF, 500 V, DM10 | C1267 |
| C51 | Capacitor, 100 pF, 500 V, DM10 | C1156 |
| C52 | Capacitor, 33 pF, 500 V, DM10 | C1268 |
| C53 | Capacitor, 18 pF, 500 V, DM10 | C0697 |
| CR1 | Diode, 1N747A | CR5005 |
| CR2 | Not Used | |
| CR3 | Not Used | |
| CR4 | Not Used | |
| CR5 | Not Used | |
| CR6 | Diode, 1N4151 | CR0150 |
| J1 | Integrated Circuit Socket, 14 Pin | X0186 |
| J2 | Integrated Circuit Socket, 14 Pin | X0186 |
| J3 | Not Used | |
| J4 | Connector, Post, AMP 61067-1 | E0318 |
| K1 | Relay, Printact #12BP3G | K0135 |
| L1 | Inductor, 100 µH | L0073 |
| L2 | Inductor, 100 µH | L0073 |
| L3 | Inductor, 27 µH | L0076 |
| L4 | Inductor, .06 µH | L0158 |
| L5 | Inductor, .06 µH | L0158 |
| L6 | Inductor, .06 µH | L0158 |
| L7 | Inductor, .06 µH | L0158 |
| L8 | Inductor, 270 µH, WEE | L0067 |
| Q1 | Transistor, 2N3646 | Q0218 |
| Q2 | Transistor, 40673 | Q0297 |
| Q3 | Transistor, 2N5179 | Q0269 |
| Q4 | Transistor, 2N3646 | Q0218 |
| Q5 | Transistor, 2N5179 | Q0269 |

| Ref. | Description | SD Part No. |
|---|---|---|
| Q6 | Transistor, 2N5179 | Q0269 |
| Q7 | Transistor, 2N5179 | Q0269 |
| Q8 | Transistor, 2N5179 | Q0269 |
| Q9 | Transistor, 2N5179 | Q0269 |
| Q10 | Transistor, 2N5179 | Q0269 |
| Q11 | Transistor, 2N5179 | Q0269 |
| Q12 | Transistor, 2N5179 | Q0269 |
| Q13 | Transistor, 2N3646 | Q0218 |
| Q14 | Transistor, 2N3640 | Q0178 |
| Q15 | Transistor, 2N3640 | Q0178 |
| Q16 | Transistor, 2N3646 | Q0218 |
| Q17 | Transistor, 2N3645 | Q0215 |
| Q18 | Transistor, 2N3646 | Q0218 |
| Q19 | Transistor, 2N3640 | Q0178 |
| R1 | Resistor, 22 Ω, 1/4 W, 5% | R1436 |
| R2 | Resistor, 100 k, 1/4 W, 5% | R0741 |
| R3 | Resistor, 120 Ω, 1/4 W, 5% | R1461 |
| R4 | Resistor, 1 MΩ, 1/4 W, 5% | R0692 |
| R5 | Resistor, 10 k, 1/4 W, 5% | R0766 |
| R6 | Resistor, 120 Ω, 1/4 W, 5% | R1461 |
| R7 | Resistor, 220 Ω, 1/4 W, 5% | R0760 |
| R8 | Resistor, 100 Ω, 1/4 W, 5% | R0966 |
| R9 | Resistor, 4.7 k, 1/4 W, 5% | R0892 |
| R10 | Resistor, 220 Ω, 1/4 W, 5% | R0760 |
| R11 | Resistor, 820 Ω, 1/4 W, 5% | R0762 |
| R12 | Resistor, 10 Ω, 1/4 W, 5% | R0739 |
| R13 | Resistor, 47 Ω, 1/4 W, 5% | R0743 |
| R14 | Resistor, 330 Ω, 1/4 W, 5% | R0662 |
| R15 | Resistor, 680 Ω, 1/4 W, 5% | R1234 |
| R16 | Resistor, 270 Ω, 1/4 W, 5% | R0694 |
| R17 | Resistor, 360 Ω, 1/4 W, 5% | R1571 |
| R18 | Resistor, 33 Ω, 1/4 W, 5% | R1550 |
| R19 | Resistor, 47 Ω, 1/4 W, 5% | R0743 |
| R20 | Resistor, 560 Ω, 1/4 W, 5% | R0819 |
| R21 | Resistor, 150 Ω, 1/4 W, 5% | R0983 |
| R22 | Resistor, 33 Ω, 1/4 W, 5% | R1550 |
| R23 | Resistor, 680 Ω, 1/4 W, 5% | R1234 |
| R24 | Resistor, 150 Ω, 1/4 W, 5% | R0983 |
| R25 | Resistor, 390 Ω, 1/4 W, 5% | R0880 |
| R26 | Resistor, 100 k, 1/4 W, 5% | R0741 |

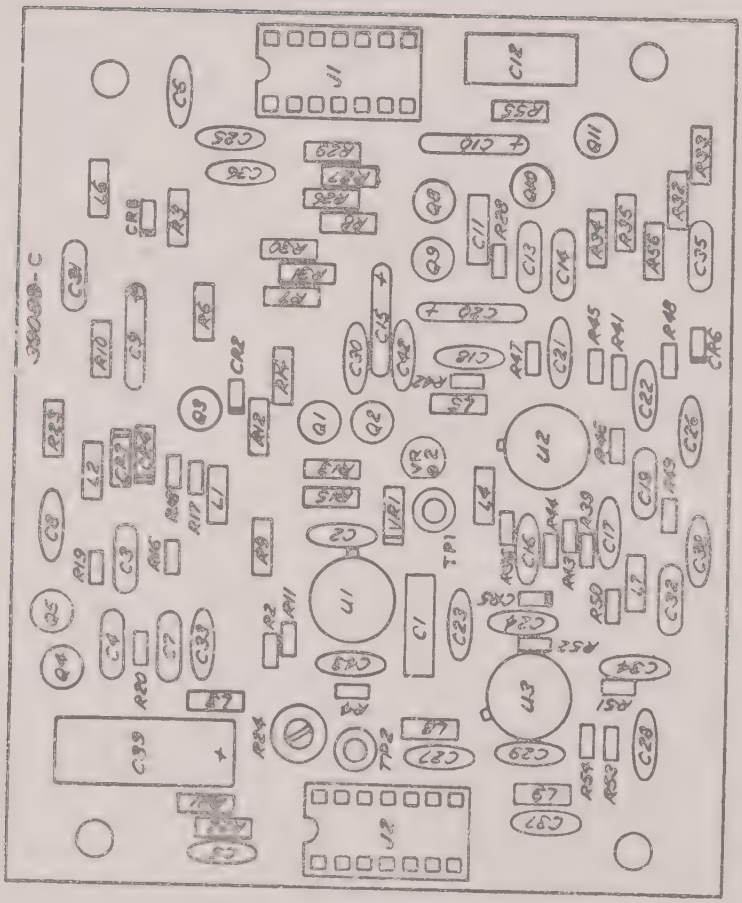
## A4 200MHz AMP & DECADE PARTS LIST (Cont'd)

| Ref. | Description | SD Part No. |
|---|---|---|
| R27 | Resistor, 22 Ω, 1/8 W, 5% | R1448 |
| R28 | Resistor, 47 Ω, 1/4 W, 5% | R0743 |
| R29 | Resistor, 360 Ω, 1/4 W, 5% | R1571 |
| R30 | Resistor, 100 Ω, 1/4 W, 5% | R0966 |
| R31 | Resistor, 22 Ω, 1/8 W, 5% | R1448 |
| R32 | Resistor, 390 Ω, 1/4 W, 5% | R0880 |
| R33 | Resistor, 390 Ω, 1/4 W, 5% | R0880 |
| R34 | Resistor, 2.2 k, 1/4 W, 5% | R0794 |
| R35 | Resistor, 2.2 k, 1/4 W, 5% | R0794 |
| R36 | Resistor, 1.2 k, 1/4 W, 5% | R0809 |
| R37 | Resistor, 1.2 k, 1/4 W, 5% | R0809 |
| R38 | Resistor, 560 Ω, 1/4 W, 5% | R0819 |
| R39 | Resistor, 910 k, 1/4 W, 5% | R2312 |
| R40 | Resistor, 270 Ω, 1/4 W, 5% | R0694 |
| R41 | Resistor, 270 Ω, 1/4 W, 5% | R0694 |
| R42 | Resistor, 270 Ω, 1/4 W, 5% | R0694 |
| R43 | Resistor, 270 Ω, 1/4 W, 5% | R0694 |
| R44 | Not Used | |
| R45 | Resistor, 100 k, 1/4 W, 5% | R0741 |
| R46 | Resistor, 10 k, 1/4 W, 5% | R0766 |
| R47 | Resistor, 10 k, Potentiometer, CTS 340 | R2383 |
| R48 | Resistor, 2.2 k, 1/4 W, 5% | R0794 |
| R49 | Resistor, 3 k, 1/4 W, 5% | R0711 |
| R50 | Resistor, 5 k, Potentiometer, CTS 340 | R2187 |
| R51 | Resistor, 100 k, 1/4 W, 5% | R0741 |
| R52 | Resistor, 820 Ω, 1/4 W, 5% | R0762 |
| R53 | Resistor, 33 k, 1/4 W, 5% | R0780 |
| R54 | Resistor, 33 k, 1/4 W, 5% | R0780 |
| R55 | Resistor, 47 k, 1/4 W, 5% | R0777 |
| R56 | Resistor, 47 k, 1/4 W, 5% | R0777 |
| R57 | Resistor, 4.7 k, 1/4 W, 5% | R0892 |
| R58 | Resistor, 22 k, 1/4 W, 5% | R0768 |
| R59 | Resistor, 56 Ω, 1/4 W, 5% | R1554 |
| R60 | Resistor, 3.3 k, 1/4 W, 5% | R0742 |
| R61 | Resistor, 4.7 k, 1/4 W, 5% | R0892 |
| R62 | Resistor, 47 Ω, 1/4 W, 5% | R0743 |
| U1 | Integrated Circuit, LM301A | 25745 |
| U2 | Integrated Circuit, MC1026P | 25780 |
| U3 | Integrated Circuit, MC1670L | 25765 |
| U4 | Integrated Circuit, MC1027P | 25719 |
| U5 | Integrated Circuit, MC1027P | 25719 |

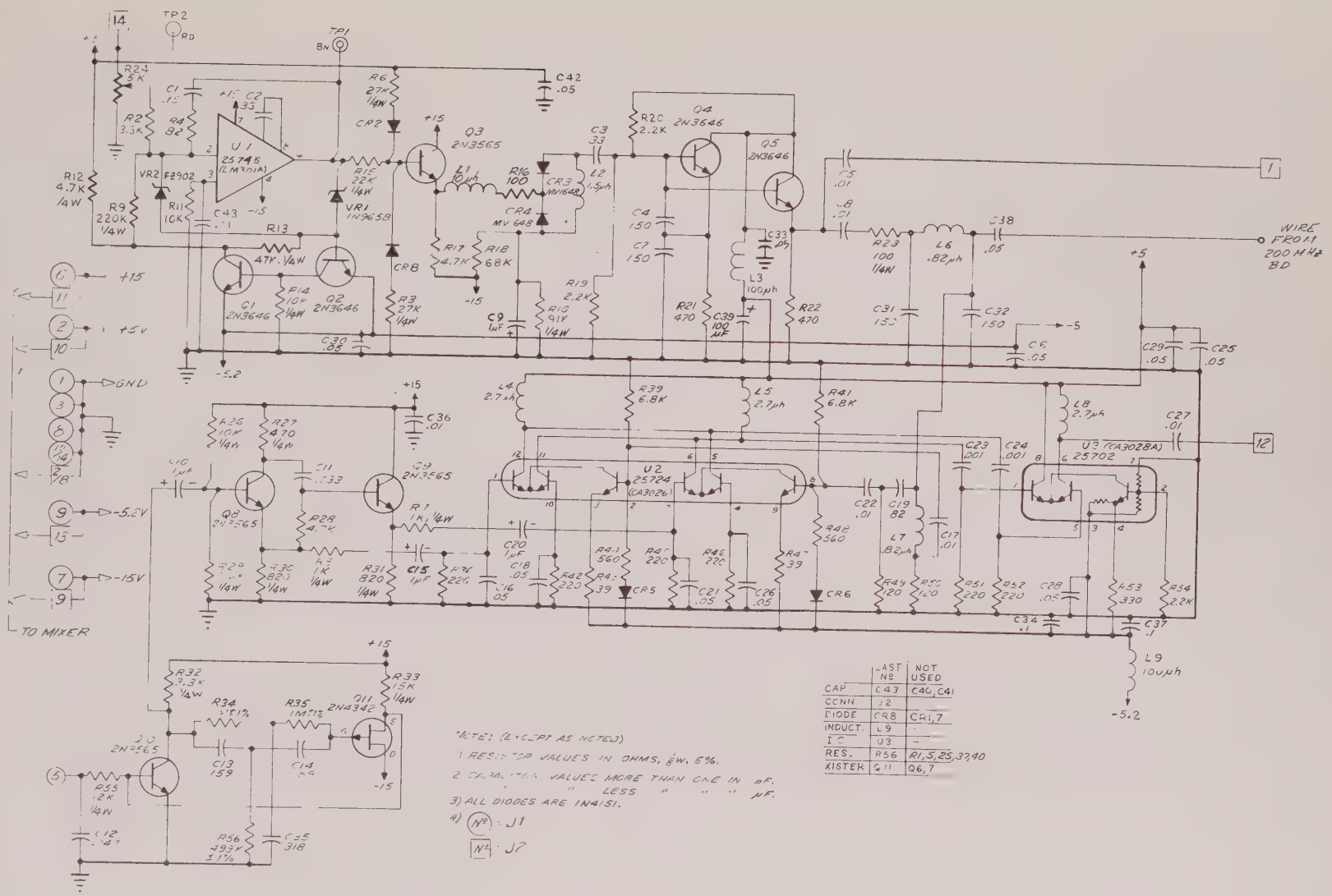
## A4 200MHz AMP & DECADE PARTS LIST (Cont'd)

| Ref. | Description | SD Part No. |
|---|---|---|
| U6 | Integrated Circuit, MC1027P | 25719 |
| U7 | Integrated Circuit, MC1039 | 25774 |
| R63 | Resistor, 910 k, 1/4 W, 5% | R2312 |
| R64 | Resistor, 22 Ω, 1/4 W, 5% | R1436 |
| R65 | Resistor, 100 k, 1/4 W, 5% | R0741 |
| R66 | Resistor, 39 Ω, 1/8 W, 5% | R1829 |
| XQ1 | Not Used | |
| XQ2 | Transistor Pad | H1838 |
| XQ3 | Transistor Pad | H1838 |
| XQ4 | Not Used | |
| XQ5 | Transistor Pad | H1838 |
| XQ6 | Transistor Pad | H1838 |
| XQ7 | Transistor Pad | H1838 |
| XQ8 | Transistor Pad | H1838 |
| XQ9 | Transistor Pad | H1838 |
| XQ10 | Transistor Pad | H1838 |
| XQ11 | Transistor Pad | H1838 |
| XQ12 | Transistor Pad | H1838 |
| XQ13 | Not Used | |
| XQ14 | Not Used | |
| XQ15 | Not Used | |
| XQ16 | Not Used | |
| XQ17 | Transistor Pad | H0515 |
| XJ1 | Insulator, 14 Hole | H1958 |
| XJ2 | Insulator, 14 Hole | H1958 |

NOTES



A5, ACTO P.C. ASSEMBLY, C39090E




| | PART № | NOT USED |
|---|---|---|
| CAP | C43 | C40, C41 |
| CONN | J2 | |
| DIODE | CR8 | CR1,7 |
| INDUCT. | L9 | |
| IC | U3 | |
| RES. | R56 | R1,5,25,37,40 |
| XISTER | Q11 | Q6,7 |

A5, ACTO SCHEMATIC, C39087D

# A5 ACTO PARTS LIST

| Ref. | Description | SD Part No. |
|---|---|---|
| | A5 ACTO P.C. Assembly | C39090 |
| | A5 ACTO Schematic | C39087 |
| C1 | Capacitor, .15 µF, 100 V | C0237 |
| C2 | Capacitor, 33 pF, 500 V | C0531 |
| C3 | Capacitor, 33 pF, 500 V | C0531 |
| C4 | Capacitor, 150 pF, 500 V | C0537 |
| C5 | Capacitor, .01 µF, 100 V | C0556 |
| C6 | Capacitor, .05 µF, 12 V | C0672 |
| C7 | Capacitor, 150 pF, 500 V | C0537 |
| C8 | Capacitor, .01 µF, 100 V | C0556 |
| C9 | Capacitor, 1 µF, 35 V, Tant | C0524 |
| C10 | Capacitor, 1 µF, 35 V, Tant | C0524 |
| C11 | Capacitor, .033 µF, 100 V | C0735 |
| C12 | Capacitor, .047 µF, 200 V | C0700 |
| C13 | Capacitor, 159 pF, 500 V, 1% | C1146 |
| C14 | Capacitor, 159 pF, 500 V, 1% | C1146 |
| C15 | Capacitor, 1 µF, 35 V, Tant | C0524 |
| C16 | Capacitor, .05 µF, 12 V | C0672 |
| C17 | Capacitor, .01 µF, 100 V | C0556 |
| C18 | Capacitor, .05 µF, 12 V | C0672 |
| C19 | Capacitor, 82 pF, 500 V | C0535 |
| C20 | Capacitor, 1 µF, 35 V, Tant | C0524 |
| C21 | Capacitor, .05 µF, 12 V | C0672 |
| C22 | Capacitor, .01 µF, 100 V | C0556 |
| C23 | Capacitor, .001 µF, 1 KV | C0235 |
| C24 | Capacitor, .001 µF, 1 KV | C0235 |
| C25 | Capacitor, .05 µF, 12 V | C0672 |
| C26 | | |
| C26 | Capacitor, .05 µF, 12 V | C0672 |
| C27 | Capacitor, .01 µF, 100 V | C0556 |
| C28 | Capacitor, .05 µF, 12 V | C0672 |
| C29 | Capacitor, .05 µF, 12 V | C0672 |
| C30 | Capacitor, .05 µF, 12 V | C0672 |
| C31 | Capacitor, 150 pF, 500 V | C0537 |
| C32 | Capacitor, 150 pF, 500 V | C0537 |
| C33 | Capacitor, .05 µF, 12 V | C0672 |
| C34 | Capacitor, .1 µF, 10 V | C0661 |
| C35 | Capacitor, 318 pF, 500 V, 1% | C1145 |
| C36 | Capacitor, .01 µF, 100 V | C0556 |
| C37 | Capacitor, .1 µF, 10 V | C0661 |
| C38 | Capacitor, .05 µF, 12 V | C0672 |
| C39 | Capacitor, 100 µF, 10 V | C0660 |

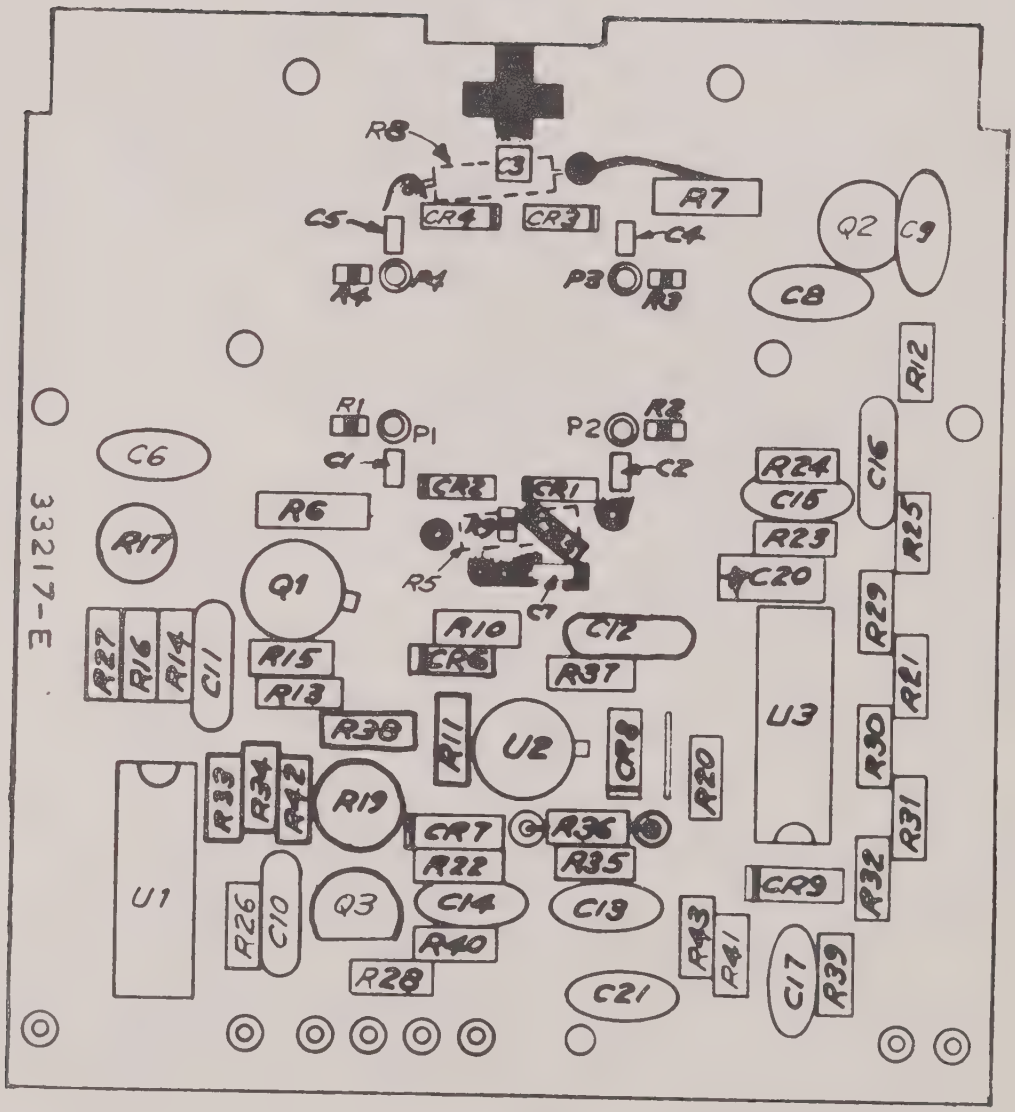
## A5 ACTO PARTS LIST (Cont'd)

| Ref. | Description | SD Part No. |
|---|---|---|
| C40 | Not Used | |
| C41 | Not Used | |
| C42 | Capacitor, .05 µF, 12 V | C0672 |
| C43 | Capacitor, .01 µF, 100 V | C0556 |
| CR1 | Not Used | |
| CR2 | Diode, 1N4151 | CR0150 |
| CR3 | Diode, MV1648 | CR0359 |
| CR4 | Diode, MV1648 | CR0359 |
| CR5 | Diode, 1N4151 | CR0150 |
| CR6 | Diode, 1N4151 | CR0150 |
| CR7 | Not Used | |
| CR8 | Diode, 1N4151 | CR0150 |
| J1 | Connector, Socket, I.C., 14 Term | X0186 |
| J2 | Connector, Socket, I.C., 14 Term | X0184 |
| L1 | Inductor, 10 µH | L0153 |
| L2 | Inductor, 1.5 µH | L0164 |
| L3 | Inductor, 100 µH | L0156 |
| L4 | Inductor, 2.7 µH | L0165 |
| L5 | Inductor, 2.7 µH | L0165 |
| L6 | Inductor, .82 µH | L0163 |
| L7 | Inductor, .82 µH | L0163 |
| L8 | Inductor, 2.7 µH | L0165 |
| L9 | Inductor, 100 µH | L0156 |
| Q1 | Transistor, 2N3646 | Q0218 |
| Q2 | Transistor, 2N3646 | Q0218 |
| Q3 | Transistor, 2N3565 | Q0237 |
| Q4 | Transistor, 2N3646 | Q0218 |
| Q5 | Transistor, 2N3646 | Q0218 |
| Q6 | Not Used | |
| Q7 | Not Used | |
| Q8 | Transistor, 2N3565 | Q0237 |
| Q9 | Transistor, 2N3565 | Q0237 |
| Q10 | Transistor, 2N3565 | Q0237 |
| Q11 | Transistor, 2N4342 | Q0243 |
| R1 | Not Used | |
| R2 | Resistor, 3.3 k, 1/8 W, 5% | R1456 |
| R3 | Resistor, 27 k, 1/8 W, 5% | R0824 |
| R4 | Resistor, 82 Ω, 1/8 W, 5% | R1745 |
| R5 | Not Used | |

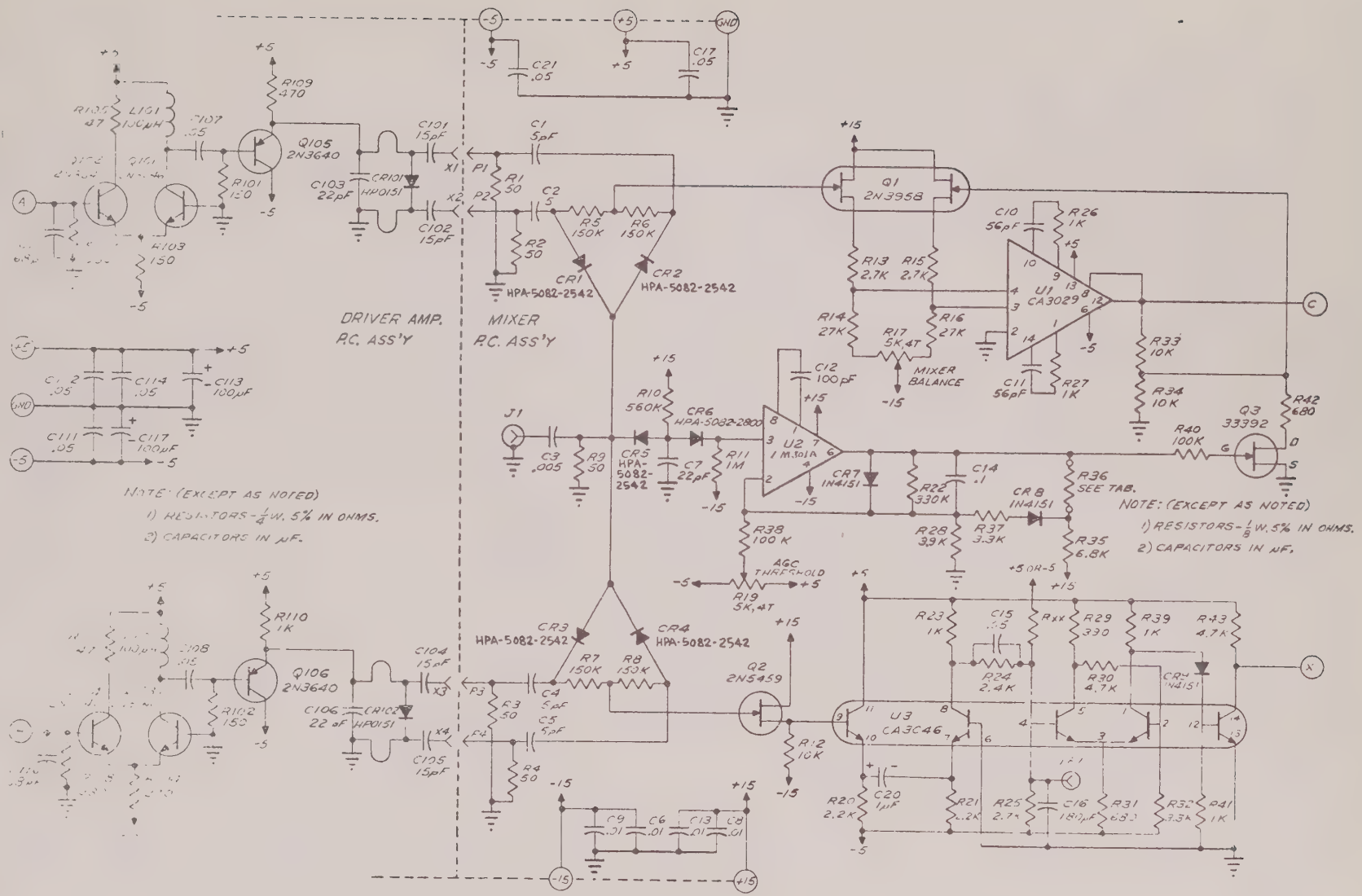
## A5 ACTO PARTS LIST (Cont'd)

| Ref. | Description | SD Part No. |
|---|---|---|
| R6 | Resistor, 27 k, 1/8 W, 5% | R0824 |
| R7 | Resistor, 1 k, 1/8 W, 5% | R0765 |
| R8 | Resistor, 1 k, 1/8 W, 5% | R0765 |
| R9 | Resistor, 220 k, 1/4 W, 5% | R0967 |
| R10 | Resistor, 91 k, 1/4 W, 5% | R1481 |
| R11 | Resistor, 10 k, 1/8 W, 5% | R1437 |
| R12 | Resistor, 4.7 k, 1/4 W, 5% | R0892 |
| R13 | Resistor, 47 k, 1/4 W, 5% | R0777 |
| R14 | Resistor, 10 k, 1/4 W, 5% | R0766 |
| R15 | Resistor, 22 k, 1/4 W, 5% | R0768 |
| R16 | Resistor, 100 Ω, 1/8 W, 5% | R1441 |
| R17 | Resistor, 4.7 k, 1/8 W, 5% | R1733 |
| R18 | Resistor, 68 k, 1/8 W, 5% | R1849 |
| R19 | Resistor, 2.2 k, 1/8 W, 5% | R1476 |
| R20 | Resistor, 2.2 k, 1/8 W, 5% | R1476 |
| R21 | Resistor, 470 Ω, 1/8 W, 5% | R1451 |
| R22 | Resistor, 470 Ω, 1/8 W, 5% | R1451 |
| R23 | Resistor, 100 Ω, 1/4 W, 5% | R0966 |
| R24 | Resistor, VAR., 5 k, 2 W, 30% | R2187 |
| R25 | Not Used | |
| R26 | Resistor, 10 k, 1/4 W, 5% | R0766 |
| R27 | Resistor, 470 Ω, 1/4 W, 5% | R1044 |
| R28 | Resistor, 4.7 k, 1/8 W, 5% | R1733 |
| R29 | Resistor, 5.6 k, 1/4 W, 5% | R0821 |
| R30 | Resistor, 820 Ω, 1/4 W, 5% | R0762 |
| R31 | Resistor, 820 Ω, 1/4 W, 5% | R0762 |
| R32 | Resistor, 3.3 k, 1/4 W, 5% | R0742 |
| R33 | Resistor, 15 k, 1/4 W, 5% | R0728 |
| R34 | Resistor, 1 MΩ, 1/8 W, 5% | R2371 |
| R35 | Resistor, 1 MΩ, 1/8 W, 5% | R2371 |
| R36 | Resistor, 220 Ω, 1/8 W, 5% | R1743 |
| R37 | Not Used | |
| R38 | Not Used | |
| R39 | Resistor, 6.8 k, 1/8 W, 5% | R1459 |
| R40 | Not Used | |
| R41 | Resistor, 6.8 k, 1/8 W, 5% | R1459 |
| R42 | Resistor, 220 Ω, 1/8 W, 5% | R1743 |
| R43 | Resistor, 39 Ω, 1/8 W, 5% | R1829 |
| R44 | Resistor, 560 Ω, 1/8 W, 5% | R1452 |
| R45 | Resistor, 220 Ω, 1/8 W, 5% | R1743 |
| R46 | Resistor, 220 Ω, 1/8 W, 5% | R1743 |

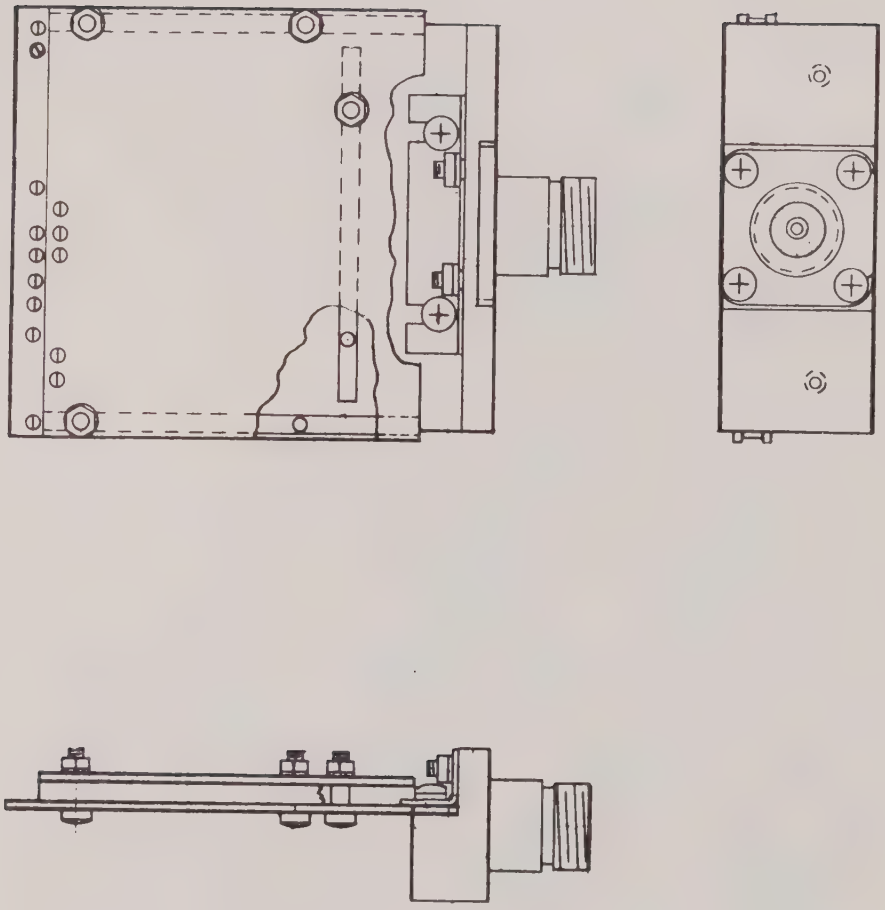
| Ref. | Description | SD Part No. |
|---|---|---|
| R47 | Resistor, 39 Ω, 1/8 W, 5% | R1829 |
| R48 | Resistor, 560 Ω, 1/8 W, 5% | R1452 |
| R49 | Resistor, 120 Ω, 1/8 W, 5% | R2459 |
| R50 | Resistor, 120 Ω, 1/8 W, 5% | R2459 |
| R51 | Resistor, 220 Ω, 1/8 W, 5% | R1743 |
| R52 | Resistor, 220 Ω, 1/8 W, 5% | R1743 |
| R53 | Resistor, 330 Ω, 1/8 W, 5% | R1444 |
| R54 | Resistor, 2.2 k, 1/8 W, 5% | R1476 |
| R55 | Resistor, 12 k, 1/4 W, 5% | R0759 |
| R56 | Resistor, 499 k, 1/8 W, 1% | R2372 |
| TP1 | Test Point, Brown | E0284 |
| TP2 | Test Point, Red | E0279 |
| U1 | Integrated Circuit, LM301A | 25745 |
| U2 | Integrated Circuit, CA3026 | 25724 |
| U3 | Integrated Circuit, CA3028A | 25702 |
| VR1 | Zener, 1N965B | CR0139 |
| VR2 | Zener, FZ902 | 26015850 |
| XJ1 & J2 | Retainer, Plug | A39976 |
| XJ1 & J2 | Insulator, 14 Hole | H1958 |




A6, MIXER P.C. ASSEMBLY, C33218J




A6, MIXER & DRIVER AMP SCHEMATIC, C27988L



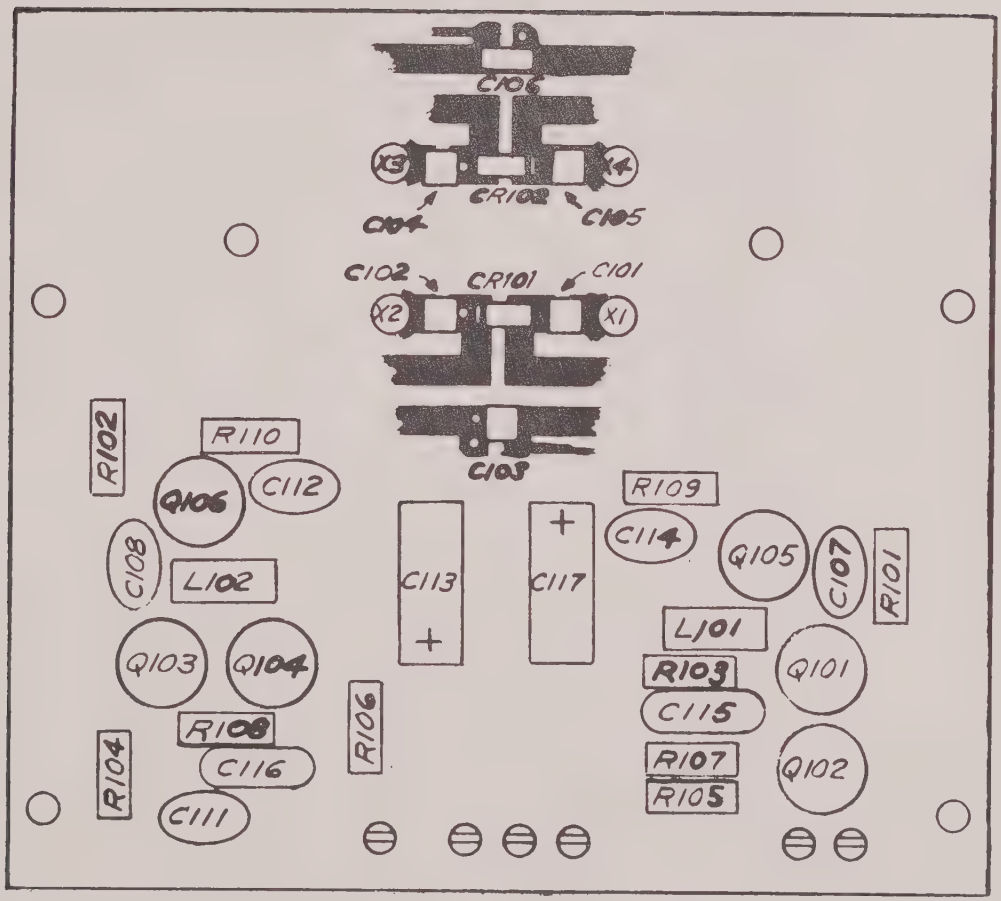
A6, MIXER FINAL ASSEMBLY, C33351B

# A6 MIXER PARTS LIST

| Ref. | Description | SD Part No. |
|---|---|---|
| | Mixer P.C. Assembly | C33218C |
| | Mixer Schematic | C27988C |
| C1 | Capacitor, 5 pF, Chip | C1187 |
| C2 | Capacitor, 5 pF, Chip | C1187 |
| C3 | Capacitor, .005 µF, Chip | C1245 |
| C4 | Capacitor, 5 pF, Chip | C1187 |
| C5 | Capacitor, 5 pF, Chip | C1187 |
| C6 | Capacitor, .01 µF, 100 V, Disc | C0556 |
| C7 | Capacitor, 22 pF, 25 V, Disc, Chip | C1177 |
| C8 | Capacitor, .01 µF, 100 V, Disc | C0556 |
| C9 | Capacitor, .01 µF, 100 V, Disc | C0556 |
| C10 | Capacitor, 56 pF, 500 V, DM | C0882 |
| C11 | Capacitor, 56 pF, 500 V, DM | C0882 |
| C12 | Capacitor, 100 pF, 500 V, DM | C0536 |
| C13 | Capacitor, .01 µF, 100 V, Disc | C0556 |
| C14 | Capacitor, .1 µF, 10 V, Disc | C0661 |
| C15 | Capacitor, .05 µF, 12 V, Disc | C0672 |
| C16 | Capacitor, 180 pF, 500 V, DM | C1138 |
| C17 | Capacitor, .05 µF, 12 V, Disc | C0672 |
| C18 | Not Used | |
| C19 | Not Used | |
| C20 | Capacitor, 1 µF, 35 V, Tant | C0524 |
| C21 | Capacitor, .05 µF, 12 V, Disc | C0672 |
| CR1 | Diode, HPA-5082-2542 | CR0358 |
| CR2 | Diode, HPA-5083-2542 | CR0358 |
| CR3 | Diode, HPA-5083-2542 | CR0358 |
| CR4 | Diode, HPA-5083-2542 | CR0358 |
| CR5 | Diode, HPA-5083-2542 | CR0358 |
| CR6 | Diode, HPA 5082-2800 | CR0363 |
| CR7 | Diode, 1N4151 | CR0150 |
| CR8 | Diode, 1N4151 | CR0150 |
| CR9 | Diode, 1N4151 | CR0150 |
| Q1 | Transistor, 2N3958 | 26015100 |
| Q2 | Transistor, 2N5459 | Q0264 |
| Q3 | Transistor, SD Spec 33392 | 33392 |
| R1 | Resistor, 50 Ω, Chip | R2494 |
| R2 | Resistor, 50 Ω, Chip | R2494 |
| R3 | Resistor, 50 Ω, Chip | R2494 |
| R4 | Resistor, 50 Ω, Chip | R2494 |
| R5 | Resistor, 150 k, 1/4 W, 1%, MF | R2421 |

## A6 MIXER PARTS LIST (Cont'd)

| Ref. | Description | SD Part No. |
|---|---|---|
| R6 | Resistor, 150 k, 1/4 W, 1%, MF | R2421 |
| R7 | Resistor, 150 k, 1/4 W, 1%, MF | R2421 |
| R8 | Resistor, 150 k, 1/4 W, 1%, MF | R2421 |
| R9 | Resistor, 50 Ω, Chip | R2494 |
| R10 | Resistor, 560 k, 1/8 W, 5% | R2536 |
| R11 | Resistor, 1 M, 1/8 W, 5% | R1435 |
| R12 | Resistor, 10 k, 1/8 W, 5% | R1437 |
| R13 | Resistor, 2.7 k, 1/8 W, 5% | R1749 |
| R14 | Resistor, 27 k, 1/8 W, 5% | R2432 |
| R15 | Resistor, 2.7 k, 1/8 W, 5% | R1749 |
| R16 | Resistor, 27 k, 1/8 W, 5% | R2432 |
| R17 | Resistor, 5 k, Potentiometer 4 Turn | R2697 |
| R18 | Not Used | |
| R19 | Resistor, 5 k, Potentiometer 4 Turn, 1/8 W, 5% | R2697 |
| R20 | Resistor, 2.2 k, 1/8 W, 5% | R1476 |
| R21 | Resistor, 2.2 k, 1/8 W, 5% | R1476 |
| R22 | Resistor, 330 k, 1/8 W, 5% | R2535 |
| R23 | Resistor, 1 k, 1/8 W, 5% | R1453 |
| R24 | Resistor, 2.4 k, 1/8 W, 5% | R2358 |
| R25 | Resistor, 2.7 k, 1/8 W, 5% | R1749 |
| R26 | Resistor, 1 k, 1/8 W, 5% | R1453 |
| R27 | Resistor, 1 k, 1/8 W, 5% | R1453 |
| R28 | Resistor, 3.9 k, 1/8 W, 5% | R1457 |
| R29 | Resistor, 390 Ω, 1/8 W, 5% | R1450 |
| R30 | Resistor, 4.7 k, 1/8 W, 5% | R1733 |
| R31 | Resistor, 680 Ω, 1/8 W, 5% | R2461 |
| R32 | Resistor, 3.3 k, 1/8 W, 5% | R1456 |
| R33 | Resistor, 10 k, 1/8 W, 5% | R1437 |
| R34 | Resistor, 10 k, 1/8 W, 5% | R1437 |
| R35 | Resistor, 6.8 k, 1/8 W, 5% | R1459 |
| R36 | Resistor Selected | |
| R37 | Resistor, 3.3 k, 1/8 W, 5% | R1456 |
| R38 | Resistor, 100 k, 1/8 W, 5% | R2465 |
| R39 | Resistor, 1 k, 1/8 W, 5% | R1453 |
| R40 | Resistor, 100 k, 1/8 W, 5% | R2465 |
| R41 | Resistor, 1 k, 1/8 W, 5% | R1453 |
| R42 | Resistor, 680 Ω, 1/8 W, 5% | R2461 |
| R43 | Resistor, 4.7 k, 1/8 W, 5% | R1733 |
| U1 | Integrated Circuit, CA3029 | 25757 |
| U2 | Integrated Circuit, LM301A | 25745 |
| U3 | Integrated Circuit, CA3046 | 25725 |




A6, DRIVER AMP P.C. ASSEMBLY, C3321G

# A6 DRIVER AMP PARTS LIST

| Ref. | Description | SD Part No. |
|---|---|---|
| | A6 Driver Amp P.C. Assembly | C33221C |
| | A6 Driver Amp Schematic | C27988C |
| C101 | Capacitor, 15 pF, Chip | C1163 |
| C102 | Capacitor, 15 pF, Chip | C1163 |
| C103 | Capacitor, 22 pF, Chip | C1177 |
| C104 | Capacitor, 15 pF, Chip | C1163 |
| C105 | Capacitor, 15 pF, Chip | C1163 |
| C106 | Capacitor, 22 pF, Chip | C1177 |
| C107 | Capacitor, .05 µF, 12 V | C0672 |
| C108 | Capacitor, .05 µF, 12 V | C0672 |
| C109 | Not Used | |
| C110 | Not Used | |
| C111 | Capacitor, .05 µF, 12 V | C0672 |
| C112 | Capacitor, .05 µF, 12 V | C0672 |
| C113 | Capacitor, 100 µF, 10 V | C0660 |
| C114 | Capacitor, .05 µF, 12 V | C0672 |
| C115 | Capacitor, 68 pF, 500 V | C0635 |
| C116 | Capacitor, 68 pF, 500 V | C0635 |
| C117 | Capacitor, 100 µF, 10 V | C0660 |
| CR101 | Diode, HP0151 | CR0269 |
| CR102 | Diode, HP0151 | CR0269 |
| L101 | Inductor, 100 µH, 10% | L0073 |
| L102 | Inductor, 100 µH, 10% | L0073 |
| Q101 | Transistor, 2N3646 | Q0218 |
| Q102 | Transistor, 2N3646 | Q0218 |
| Q103 | Transistor, 2N3646 | Q0218 |
| Q104 | Transistor, 2N3646 | Q0218 |
| Q105 | Transistor, 2N3640 | Q0178 |
| Q106 | Transistor, 2N3640 | Q0178 |
| R101 | Resistor, 150 Ω, 1/4 W, 5% | R0983 |
| R102 | Resistor, 150 Ω, 1/4 W, 5% | R0983 |
| R103 | Resistor, 150 Ω, 1/4 W, 5% | R0983 |
| R104 | Resistor, 270 Ω, 1/4 W, 5% | R0694 |
| R105 | Resistor, 47 Ω, 1/4 W, 5% | R0743 |
| R106 | Resistor, 47 Ω, 1/4 W, 5% | R0743 |
| R107 | Resistor, 330 Ω, 1/4 W, 5% | R0662 |
| R108 | Resistor, 330 Ω, 1/4 W, 5% | R0662 |
| R109 | Resistor, 470 Ω, 1/4 W, 5% | R1044 |
| R110 | Resistor, 1 k, 1/4 W, 5% | R0765 |

# CHAPTER 7
# STANDARD OPTIONS

## 7.1 INTRODUCTION

The Standard Options available for the SD Model 6053/3 Frequency Counter are described in the following sections. These are extra cost items to tailor your unit for specific application. Non-standard Options may be requested and will be described in this chapter when applicable.

# OPTION 10
## OSCILLATOR (B1)

The B1 Option provides this instrument with a medium stability oscillator.

The B1 Oscillator specifications are as follows:

AGING RATE: ±7 parts in $10^9$/24 hrs. // ±2 parts in $10^8$/24 hours.

WARM-UP TIME TO REACH SPECIFIED AGING RATE: 30 days // 72 hours.

SHORT-TERM STABILITY AVERAGED OVER 1 SECOND: ±5 parts in $10^9$ rms.

LONG-TERM AGING RATE: ±3 parts in $10^9$/24 hours after 45 day dynamic.

VARIATION WITH TEMPERATURE: ±5 parts in $10^9$/C° from -20° to +50°C.

10% CHANGE IN LINE VOLTAGE: <±2 parts in $10^9$.

Parts List

| Ref. | Description | SD Part No. |
|---|---|---|
| U1 | Oscillator, Heated B1 | Y0023 |

# OPTION 11
# OSCILLATOR (B3)

The B3 Option provides the instrument with a medium stability oscillator. The B3 Oscillator, unlike the standard 1 MHz oscillator, has an output frequency of 3 MHz. A divide-by-three circuit has been added to convert the oscillator's output frequency to the required 1 MHz reference.

The B3 Option comprises the B3 Oscillator, a separate power supply, and a divide-by-three circuit (refer to the Oscillator Power Supply). The improved specifications are listed below:

AGING RATE: ±3 parts in $10^9$/24 hrs.

WARM-UP TIME TO REACH SPECIFIED AGING RATE: 72 hrs.

SHORT-TERM STABILITY AVERAGED OVER 1 SECOND: ±1 part in $10^{10}$ rms.

LONG-TERM AGING RATE: ±3 parts in $10^8$/30 days.

VARIATION WITH TEMPERATURE (AVERAGE ±2 PARTS IN $10^{10}$/°C): 4 parts in 10 over 20° change within -20°C to +55°C.

±10% CHANGE IN LINE VOLTAGE: ±5 parts in $10^{10}$.

Parts List

| Ref. | Description | SD Part No. |
|---|---|---|
| A7 | Oscillator Power P.C. Assembly | B39487 |
| C9 | Capacitor, 500 µF, 50 V | C1243 |
| T2 | Transformer | 19805 |
| U1 | Oscillator, B3 | C33428 |

# OPTION 12
# OSCILLATOR (B)

The B Option provides the insrtument with a high stability oscillator. The B Oscillator, unlike the standard 1 MHz Oscillator, has an output frequency of 3 MHz. A divide-by-three circuit has been added to convert the oscillator's output frequency to the required 1 MHz reference frequency.

The B Option comprises the B Oscillator, a separate power supply, and a divide-by-three circuit (refer to the Oscillator Power Supply). The improved specifications are listed below:

AGING RATE: 1 part in $10^9$/24 hrs.

WARM-UP TIME TO REACH SPECIFIED AGING RATE: 72 hrs.

SHORT-TERM STABILITY AVERAGED OVER 1 SECOND: 1 part in $10^{10}$ rms.

LONG-TERM AGING RATE: ±3 parts in $10^8$/30 days.

VARIATION WITH TEMPERATURE (AVERAGE 2 PARTS IN $10^{10}$/°C): ±4 parts in $10^9$ over 20° change within -20° to +50°C.

10% CHANGE IN LINE VOLTAGE: ±5 parts in $10^{10}$.

Parts List

| Ref. | Description | SD Part No. |
|---|---|---|
| A7 | Oscillator Power P.C. Assembly | B39487 |
| C9 | Capacitor, 500 µF, 50 V | C1243 |
| T2 | Transformer | 19805 |
| U1 | Oscillator, B | C33427 |
| | Bracket, MT'g., Osc. | B39044 |
| | Wire List | A39551 |

# OPTION 13
# OSCILLATOR (B4)

The B4 Option provides the instrument with a very high stability oscillator. Specifications for this oscillator are the following:

FREQUENCY OUTPUT: 1 MHz.

STABILITY:

Temperature -- Less than 5 parts in $10^{11}$/C° from 0 to +15°C.

Aging Rate -- Less than 5 parts in $10^{10}$/24 hours after warm-up. Up to 72 hrs. may be required to reach this aging rate after lengthy "off" periods of time.

Line Voltage -- Less than ±1 part in $10^{10}$ for a 10% voltage change.

Short Term -- Less than 5 parts in $10^{11}$ rms with measurement averaging time of one second under constant enviromental and line voltage conditions.

Frequency Retrace -- After up to 24 hours of shundown, one hour is required to reach within 5 parts in $10^{9}$ of the frequency that existed at the time of turn off.

FREQUENCY ADJUST:

Range (Coarse) -- ±2 parts in $10^{6}$.

Range (fine) -- ±7 parts in $10^{8}$.

Resolution -- ±1 part in $10^{10}$.

Parts List

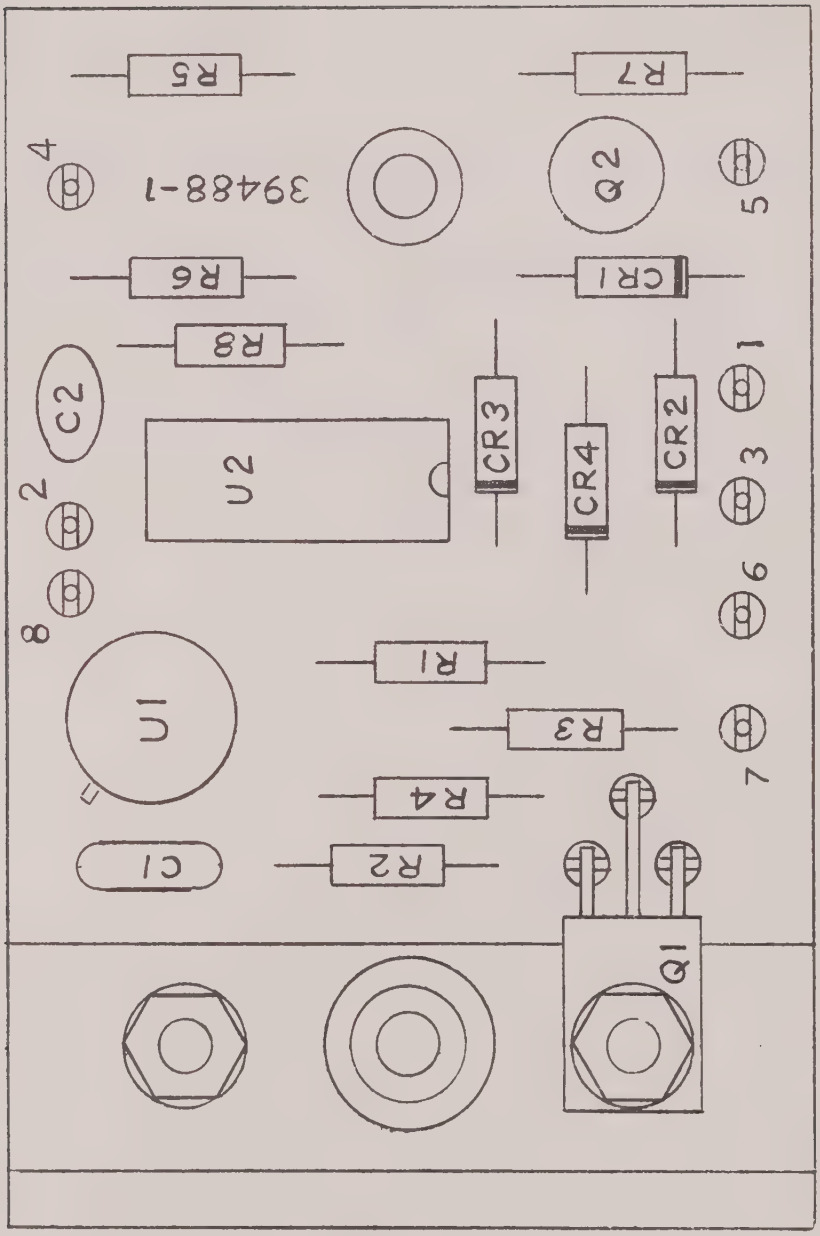
| Ref. | Description | SD Part No. |
|---|---|---|
| A7 | Oscillator Power P.C. Assembly | B39487 |
| C9 | Capacitor, 500 µF, 50 V | C1243 |
| T1 | Transformer | 19805 |
| U1 | Oscillator, B4 | C33429 |
| | Wire List | A39551 |

# CIRCUIT DESCRIPTION
## A7 OSCILLATOR, POWER SUPPLY
## SCHEMATIC #B39490R1
## (used with OPTIONS 11, 12, 13)

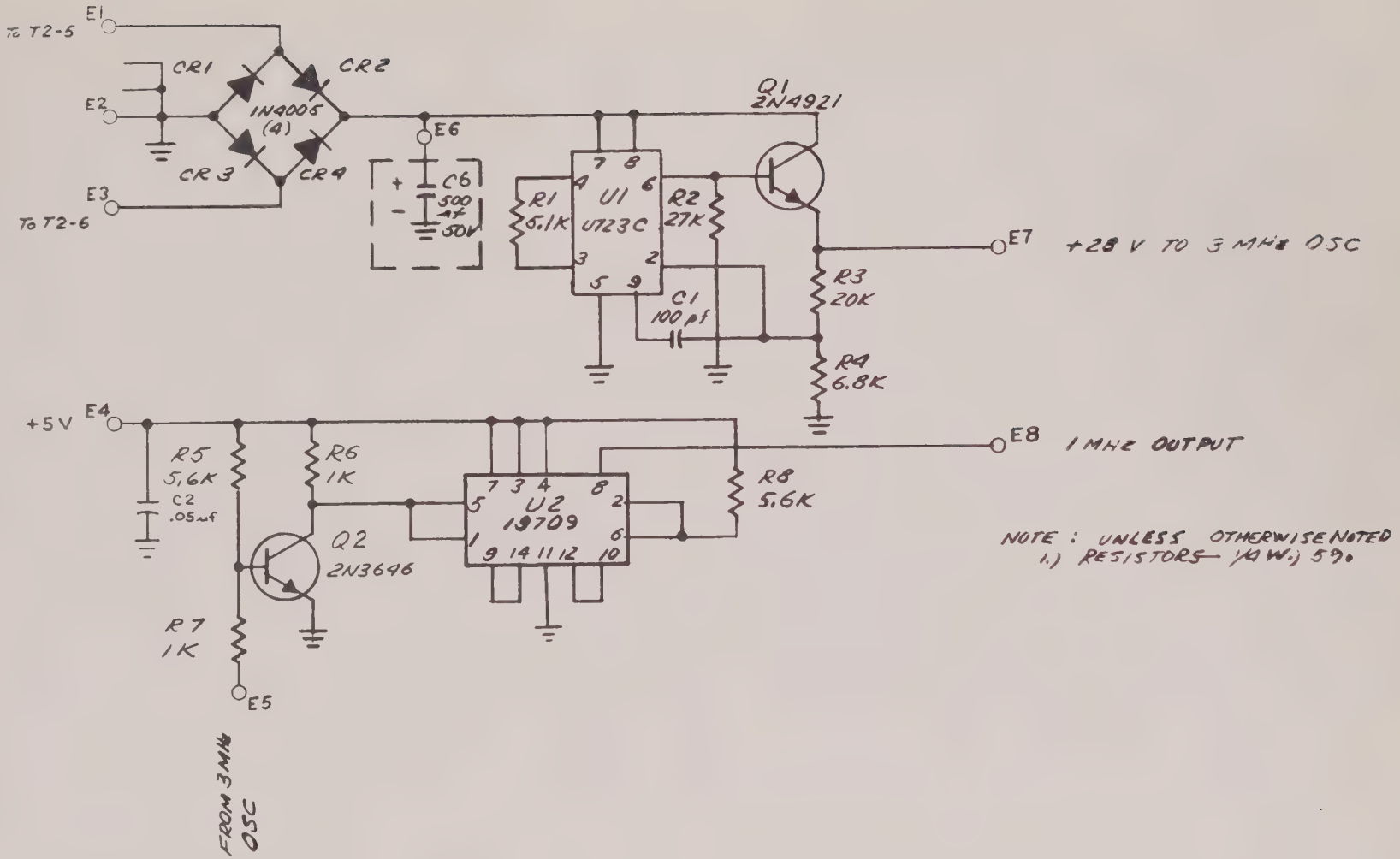
This board contains two circuits: a regulated +28 V dc power supply and a divide-by-3 circuit.

The Oscillator Power Supply consists of a full wave bridge CR1, 2, 3, 4 which supplies 28 Volts dc to regulator U1 and series pass transistor Q1. The necessary regulated 28 Volts is then fed to the oscillator.

The divide-by-3 circuit takes the 3 MHz signal from the oscillator and uses Q2 as a buffer amplifier to supply a 3 MHz signal at the proper level to the input of the divide-by-3 integrated circuit, U2. U2 divides the 3 MHz signal by 3 and produces the 1 MHz signal use by the counter.




U1, 3MHz OSCILLATOR ASSEMBLY, B39487R1




NOTE : UNLESS OTHERWISE NOTED
1.) RESISTORS — 1/4 W.) 5%.

U1, 3MHz OSCILLATOR SCHEMATIC, B39490R1

# OPTION 16
## DECADE INDICATORS (EE)

The EE Option adds two readout digits to the standard unit. When adding option EE, remove one each jumper wire as shown on drawing D33997.

Parts List

| Ref. | Description | SD Part No. |
|---|---|---|
| U51 | Integrated Circuit, SN7441N | 19707 |
| U52 | Integrated Circuit, SN7075N | 25731 |
| U53 | Integrated Circuit, SN7090N | 25732 |
| U54 | Integrated Circuit, SN7441N | 19707 |
| U55 | Integrated Circuit, SN7075N | 25731 |
| U56 | Integrated Circuit, SB7090N | 25732 |
| V8 | Tube, Readout, NL5859S | V0131 |
| V9 | Tube, Readout, NL5859S | V0131 |

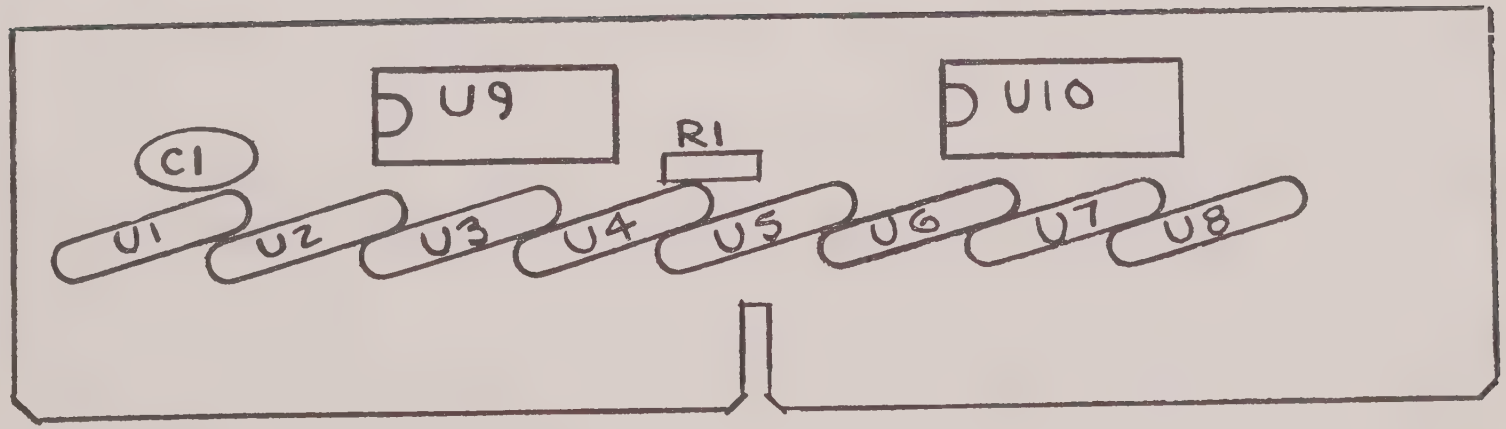
# OPTION 17
## DATA OUTPUT (D3)

BCD pin assignments:

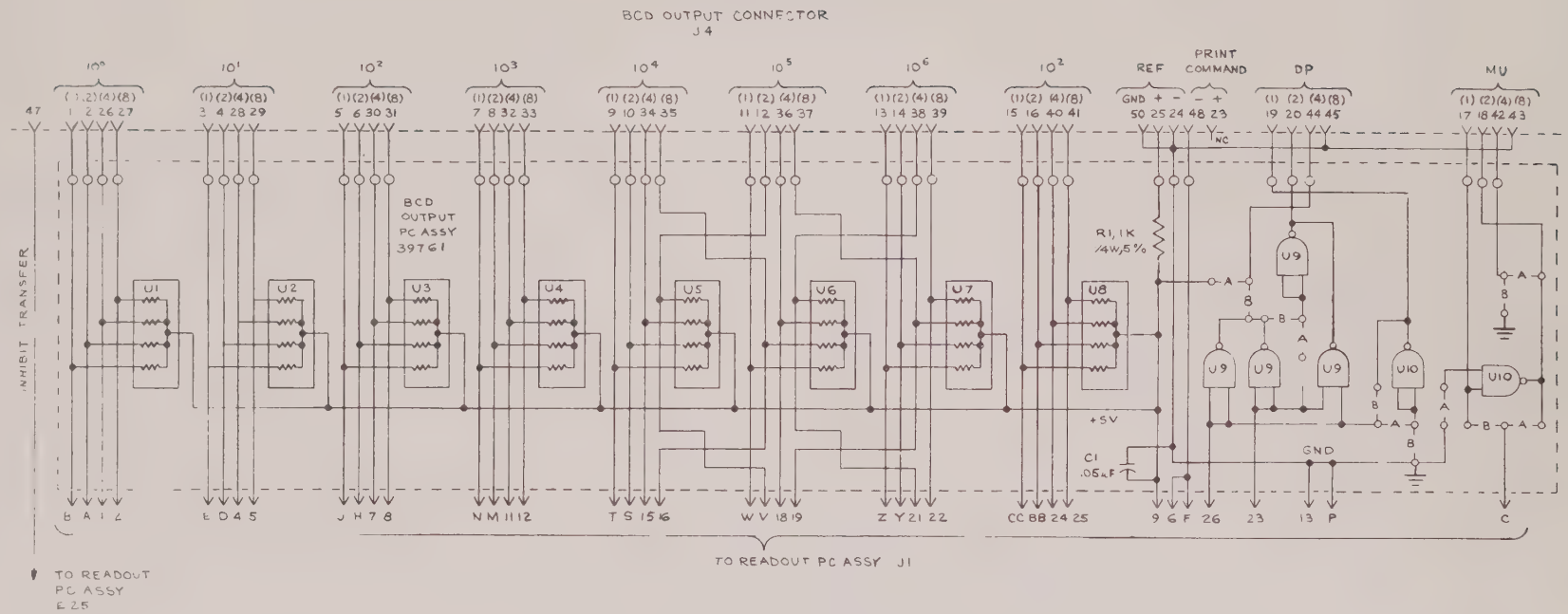
| DIGIT DISPLAYED | BCD | PIN |
|---|---|---|
| $10^0$ | 1 | 1 |
| | 2 | 2 |
| | 4 | 26 |
| | 8 | 27 |
| $10^1$ | 1 | 3 |
| | 2 | 4 |
| | 4 | 28 |
| | 8 | 29 |
| $10^2$ | 1 | 5 |
| | 2 | 6 |
| | 4 | 30 |
| | 8 | 31 |
| $10^3$ | 1 | 7 |
| | 2 | 8 |
| | 4 | 32 |
| | 8 | 33 |
| $10^4$ | 1 | 9 |
| | 2 | 10 |
| | 4 | 34 |
| | 8 | 35 |
| $10^5$ | 1 | 11 |
| | 2 | 12 |
| | 4 | 36 |
| | 8 | 37 |
| $10^6$ | 1 | 13 |
| | 2 | 14 |
| | 4 | 38 |
| | 8 | 39 |
| $10^7$ | 1 | 15 |
| | 2 | 16 |
| | 4 | 40 |
| | 8 | 41 |
| ANNUNCIATION | | |
| Measurement Unit | 1 | 17 |
| | 2 | 18 |
| | 4 | 42 |
| | 8 | 43 |
| Decimal Point | 1 | 19 |
| | 2 | 20 |
| | 4 | 44 |
| | 8 | 45 |
| RECORDER CONTROL | | |
| + Reference | | 25 |
| - Reference | | 24 |
| Instrument Ground | | 50 |
| Print Command * | | 48 |
| Inhibit Transfer | | 47 |

* 0 → +15 volt transition at end of count.

J4 (BCD OUT) Connector = Amphenol 57-40500
Mating Connector = Amphenol 57-30500




OPTION 17 (D3) BCD ASSEMBLY A39897B




| | | 1 | 2 | 4 | 8 |
|---|---|---|---|---|---|
| DP | $10^0$ | 0 | 0 | 0 | 0 |
| | $10^1$ | | 0 | 0 | 0 |
| | $10^2$ | 0 | 1 | 0 | 0 |
| | $10^3$ | 1 | 1 | 0 | 0 |
| | $10^4$ | 0 | 0 | 1 | 0 |
| | $10^5$ | 1 | 0 | 1 | 0 |
| | $10^6$ | 0 | 1 | 1 | 0 |
| | $10^7$ | | 1 | 1 | 0 |
| MU | MHz | 1 | 0 | 0 | 0 |
| | KHz | 0 | 1 | 0 | 0 |
| | μS | 1 | 0 | 1 | 0 |
| | mS | 0 | 0 | 1 | 0 |
| | SEC | 1 | 1 | 0 | 0 |

NOTES

1) J1 THRU J8 ARE 5K, 1/10W, 20% RESISTOR NETWORKS 27867
2) U9 & U10 ARE SN5846N OR EQUIV. PIN 7 GND PIN 14 +5V
3) JUMPERS 0-A-0 INSTALLED FOR MODELS 6052 & 6053
4) JUMPERS 0-B-0 INSTALLED FOR MODELS 6050 & 6051



OPTION 17 (D3) BCD SCHEMATIC C39113B

## OPTION 17 (D3) BCD PARTS LIST

| Ref. | Description | SD Part No. |
|---|---|---|
| | BCD Output Assembly | A39897B |
| | BCD Output Schematic | C39113B |
| C1 | Capacitor, .05 µF, 12 V, Disc | C0762 |
| J4 | Connector, 50 Pin | J0170 |
| R1 | Resistor, 1 k, 1/4 W, 5% | R0765 |
| U1 | Resistor Network, 5 k, 1/10 W, 20% | 27867 |
| U2 | Resistor Network, 5 k, 1/10 W, 20% | 27867 |
| U3 | Resistor Network, 5 k, 1/10 W, 20% | 27867 |
| U4 | Resistor Network, 5 k, 1/10 W, 20% | 27867 |
| U5 | Resistor Network, 5 k, 1/10 W, 20% | 27897 |
| U6 | Resistor Network, 5 k, 1/10 W, 20% | 27897 |
| U7 | Resistor Network, 5 k, 1/10 W, 20% | 27897 |
| U8 | Resistor Network, 5 k, 1/10 W, 20% | 27897 |
| U9 | Integrated Circuit, SN15846N | 19716 |
| U10 | Integrated Circuit, SN15846N | 19716 |
| P4 | Connector, 50 Pin | J0171 |

# OPTION 20
## REMOTE OPERATION (P)

Remote control pin assignments:

| PIN NO. | CONTROLS |
|---|---|
| 1 | Inhibit Reset |
| 2 | Reset (closure to ground will reset instrument only when gate is closed.) |
| 4 | FUNCTION "B" |
| 5 | FUNCTION "C" |
| 6 | FUNCTION "D" |
| 8 | RESOLUTION "B" |
| 9 | RESOLUTION "C" |
| 10 | RESOLUTION "D" |
| 12 | +5 V |
| 14 | Ground |

| DESIRED FUNCTION | GROUND PINS | DESIRED RESOLUTION | GROUND PINS |
|---|---|---|---|
| ACTO | 4 & 6 | $10^{-1}$ | NONE |
| TEST | 6 | 1 | 8 |
| X1 | NONE | 10 | 9 |
| X10 | 4 | $10^{2}$ | 8 & 9 |
| X100 | 5 | $10^{3}$ | 8 & 10 |
| X1000 | 4 & 5 | $10^{4}$ | 9 & 10 |
| | | $10^{5}$ | 8, 9, & 10 |

J4 (REMOTE CONTROL) = Amphenol 57-40140
Mating Connector = Amphenol 57-30140